SUPPLEMENT.

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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THE INCORPORATED ASSOCIATION OF MINE AGENTS OF SOUTH STAFFORDSHIRE AND EAST WORCESTERSHIRE.

The second annual meeting of members was held on Monday, at the Dudley Arms Hotel, Dudley. Mr. David Peacock presided, in the absence of the President (the Mayor of Dudley), and about sixty members were present, with several visitors. Amongst the members present were Messrs. D. Peacock, W. North, J. Lindop, T. Checkley, E. Greenway, T. Latham, W. Blakemore, M. Fletcher, J. Williamson, W. Ness, J. Cope, J. Field, W. Spruce, J. Hughes, I. Foley, J. H. Cooksey, B. Callear, J. Skidmore, J. Ritson, I. Mecham, J. Bowen, R. Evans, J. Hammonds, H. Johnson, jun., I. White, J. Lawley, J. Cole, T. Roper, B. Caswell, T. Oakes, W. Hartshorne, G. Spruce, J. Fellows, E. Davies, A. Evans, A. H. Lindop, R. Thomas, jun., J. Aston, D. Davies, and others.

Upon the walls and the tables of the room there were illustrative drawings and diagrams of the recent eruptions of Mount Vesuvius, by Mr. Jas. L. Lobley, F.G.S., London; sections of the geology of the Straits of Dover, for the purposes of the proposed French-Anglo Submarine Railway Tunnel were exhibited and explained by Mr. Henry Beckett, F.G.S., of Wolverhampton; plans of the ventilation of the Ferndale Colliery and the Oaks Colliery at the time of the explosions; sections of Lord Dartmouth's sinkings at West Bromwich, through the New Red Sandstone, in 1830, by the hon. secretary; sections of Mr. Hinck's open work and sand pit at Willenhall, by the same; sections of the Monmore Green and Moseley Hall Collieries, showing the igneous rocks through the coal measures, by Mr. H. Beckett; sections of the new mine and fire-clay coal, diluted in quality by the infusion of the white trap rock and of the igneous rock, at Darlaston, both by Mr. T. Parton; sections of the intrusion of the trap rock in the thick coal at Earl Dudley's, No. 38, Pensnett Colliery, from actual measurement, 6 ft. to 1 in., by Mr. H. Beckett and the hon. secretary; a plan of Struvé's mine ventilator, ¾ in. to a foot; general section of the Silverdale Company's coal and ironstone field, by Mr. James Bostock; a section of gate roading in the Ten-yard coal in the Earl of Dudley's three pits, Himley Colliery, in the direction of the western boundary fault, and of the heading cut across part of the same field in August, 1867; a section of a remarkable dislocation in No. 2 shallow coal pit, Fishley Colliery, Brown Hills, by Mr. Wm. Blakemore; and a section showing the effect of green rock or trap in another part of the district, by Mr. Silas Bowkley. There was also a drawing of the proposed new museum. Upon the tables there were old and modern safety-lamps, philosophical instruments, and some very interesting old pit tools, supposed to have been used 260 years ago in some open workings at the Fryer's Park Colliery, on Cannock Chase, contributed by Mr. Samuel Bailey.

The directors' report for the year 1868 was read by Mr. Henry Johnson (the hon. secretary). It was as follows:—

It is again the pleasing duty of your directors to lay before you their report for the year 1868, and to still congratulate you upon the further success of the Association, and the great interest taken in its welfare, both by its own members and the leading coal and iron masters of the district. The funds of the Association have materially increased during the past year, and there has been a considerable accession of new members during that period. The Association now numbers upwards of 160 members, which must be extremely gratifying to you, considering that this is only the second year of its existence.

The members of the Association have continued to meet once in each month throughout the year—at Dudley, Walsall, and Wolverhampton, four times each during that time, at which valuable papers have been read, and matters affecting mine management have been discussed, and instructive and pleasant reunions have taken place, but your directors have felt the desirability of having a permanent home for the Association, a building in which their periodical meetings could be held with convenience and comfort, and one that would form a museum and library for their collection of practical and modern mining appliances, as well as for their plans and publications.

Extremely interesting excursions have taken place during the last year to the famous Eastwood Collieries of Messrs. Barber, Walker, and Co., near Nottingham, and it is suggested that their New Moor Green Colliery should form the subject of another visit so soon as it is opened out, and your best thanks are due to Messrs. Barber, Walker, and Co. for their kindness on this occasion. A very interesting excursion was also made to Mr. W. H. Dawes's Black Heath Colliery, where a portion of the thick coal lies at so considerable an angle, and your best thanks are due to Mr. Dawes for the very handsome and ample manner in which he provided for the wants and comfort of the members after so laborious a journey through the workings. The next excursion was to the far-famed Pendleton and Pendlebury Collieries of Messrs. Andrew Knowles and Sons, near Manchester, and thence on to the Leeds Exhibition of Fine Arts. To those members who had the opportunity and pleasure of seeing these collieries little may be said in their praise, but those who lost that opportunity lost much, for as regards vend, winding and pumping machinery, and bank arrangements, these collieries stand exceedingly high. The quantity raised being about 20,000 tons per week, from a depth in the extreme deep of 720 yards. The best thanks of the Association are due to Messrs. Knowles for their kindness on this occasion.

The last excursion of the season took place to Messrs. Swindell and Co.'s Homer Hill Colliery, Cradley Park, to witness the working results of a 6 ft. 8 in. Guibal's patent ventilating fan, and this being the first introduction of mechanical ventilation into South Staffordshire considerable interest was attached to it. Too much cannot be said in praise of the owners having adopted the most advanced notions of mine ventilation, in order to prevent a recurrence of the sad accident with which they were visited on Nov. 11, 1867. Through the kindness of the firm, this, the last excursion of the season, was rendered a very pleasing one, and your directors would recommend a second inspection to be sought in the summer of the present year, to ascertain the efficiency and economy of such a novel mode of ventilating South Staffordshire mines.

Your directors cannot but regard excursions like these as being of the highest possible practical value to the members of this Association, and would strongly recommend their adoption on a still more extended scale during the ensuing summer months ... immed in by antiquated practices are apt to grow rusty, but intercourse ... more favoured, and probably more polished, neighbours is sure to ... a spirit of emulation, and thus conduce to the common stock of ... and human perfection and happiness. In concluding this part of the report, your directors in support of their views will claim to quote the words of a coal and iron master of great eminence in the district upon this subject, wherein he says—"I entirely sympathise with the objects of your Association in the promulgation of all scientific subjects; and, further, that most desirable object, social intercourse. Gatherings such as yours bring about emulation, and that works its own end and secures progress, a feature affecting the welfare of society to such an extent as the present day that we must all encourage it, and in our separate spheres endeavour to secure it." So much said, and so truly spoken, too, should be most encouraging to the members of this Association.

As regards a permanent home for the Association, your directors have the greatest pleasure to inform you that the negotiations commenced in October last for the purchase of a site, and the erection of a suitable museum in the town of Dudley, has every prospect of being carried out, and the plans for which will be laid before you, as also the means to be adopted to raise the necessary funds, and such proposal will, no doubt, meet with your hearty support. It is proposed to erect a suitable building adjoining the Dudley and Midland Geological Museum, and on the same level, so as to form a purely practical mining and mineralogical museum, library, and class rooms, in connection with the Dudley Geological Museum, which is so famous for its collection of Silurian and coal fossils and its scientific library. Here under one roof would be combined the purely scientific on all that relates to the geology and mining of the Black Country, and if the Government scheme for technical education, which is now under consideration, should be carried out these two museums would form a splendid nucleus for a local mining training school or college, similar to those which are in so flourishing a condition at Jermyn-street, Bristol, and other mining centres. Your directors confidently hope that before another year has passed away to see such a desideratum accomplished; and, in conclusion, express their belief that if South Staffordshire is to hold her own in the iron-making and coal-mining trades, new explorations should be encouraged, and the most efficient and economical appliances resorted to, and the greatest attention and forethought exercised by all who have the control or management of the mineral resources of the district.

The report was adopted unanimously; the working of the Association for the year, exclusive of printing, had not cost more than 33*l.*, and with the subscriptions then due it was shown that there would at the close of the meeting be a balance in favour of the Association of 300*l.* The Chairman showed that the hon. secretary, who had so very successfully managed the Association from its commencement, had again and again persistently refused to receive any money acknowledgement. The directors, therefore, asked the meeting to empower them to expend in a testimonial to him such a sum as would be creditable to the Association, and satisfactory to Mr. Johnson. The permission was granted in a manner enthusiastically complimentary to the hon. secretary.

The Hon. Secretary read two of the letters which he had received from persons who had been invited to the meeting. One was from the Chairman of the Ironmasters' Association, which appears in the report; and the other was the following:—"Clifton, Jan. 9, 1869. My Dear Sir,—It would greatly gratify me to attend the meeting. I should like amazingly to see all your faces once more. However, for the present that pleasure is denied me, this being always the busiest month in the year with me. I hope the meeting on Monday will be a happy and successful one, and I beg the favour that you will remember me most kindly to all my valued and esteemed old friends in Staffordshire.—Yours very truly, Lionel Brough. To Henry Johnson, Esq."

These very cordial sentiments from the late Government Inspector for South Staffordshire were received by the members of the Association with very conspicuous satisfaction, for the applause which rose at the conclusion of the reading of the letter was considerable.

The great event of the meeting was the reading by Mr. S. P. Bidder, jun., Assoc. Inst. C.E., of his paper "On Machines employed in Working and Breaking Down Coal, so as to avoid the Use of Gunpowder." A full-sized working machine was exhibited and described by the inventor. The machine consisted of a small hydraulic pump and ram, similar to a lifting press, and by an arrangement of metal straps connected to the machine, which are inserted in the bore-hole in the face of the coal, a series of wedges are pressed home until the coal is brought down. The machine and straps are self containing, so that the former needs no propping to support it. Twelve tons of coal had been brought down by the machine in about half an hour, and when the machine was made of best steel it would not weigh above 40 lbs. or 50 lbs. There was, he said, a marked difference in the produce wedged down by this machine as compared to that blasted down by gunpowder, for it made nearly all large coal by the machine. In fiery mines the machine would be of great importance and utility in preventing the explosions incident to blasting the coal with gunpowder. After the author had described his invention at considerable length, it seemed to be the opinion of the members present that the machine would probably not cheapen the labour or cost of getting coals down, as compared with gunpowder, but that it would most certainly be safer both in fiery and non-fiery mines, and would materially improve the marketable value of the produce by making more large coals and lumps than by blasting. The author promised, as soon as the discussion upon it was concluded at the Institution of Civil Engineers, he would send one of the machines to the Mine Agents' Association of South Staffordshire, for them to practically test its working in a mine. Several coalmasters expressed their wish to at once make arrangements with the author for a license to use it. At the present time, when so much is being said as to economising coal and the production of it, this invention seems to be of the highest practical value.

Mr. Thomas L. Plant, F.M.S., Birmingham, and the Hon. Secretary contributed jointly a paper, illustrated by excellent diagrams, which Mr. Johnson had prepared, showing the practical value of meteorological readings, as evidenced in many serious explosions which have occurred. The authors said—

Colliery explosions have occurred almost invariably in the winter months. This is not to be surprised at when we bear in mind the diminished natural facilities for ventilation in the winter season. Great atmospheric changes rarely happen at other periods of the year. A high barometer, followed quickly by a reduced value of atmospheric pressure, or a sudden change of temperature in the winter, or, what frequently takes place, important changes in both, are the most dangerous conditions for colliery purposes.

From 1845 to 1857 there were in South Yorkshire four colliery explosions—

1847—Oaks Colliery, March 4 .... Lives lost	73
1849—Darby Main Colliery, Jan. 24	75
1851—Warren Vale Colliery, Dec. 20	52
1857—Lund Hill Colliery, Feb. 19	189=389

It will thus be seen that all these explosions occurred in the winter months, between Dec. 20 and March 4. There have been, of course, many minor casualties of this class, but it will be found on reference to them that they generally happen in the winter. If we review the records of the most disastrous colliery explosions that have occurred in England and Wales during the last seven years, we shall find that the premonitory and concurrent meteorological circumstances correspond with those which characterised similar periods of coal mining calamities in former years.

COLLIERY EXPLOSIONS, 1862 TO 1868 EXCLUSIVELY.

1862.—Dec. 2, 3, 4, 5: Barometer rose each day. Dec. 6: Barometer fell; temperature, which has been rising every day from beginning of month, rose to 56°, which was excessively high for December. Colliery explosion at Edmund's Main, South Yorkshire, same day.

1866.—Dec. 9, 10, 11, 12: Atmospheric pressure and temperature in constant oscillation. Dec. 12: Barometer 0·56 in. lower than on the 11th; temperature rose 20° between minimum and 8 A.M. Dec. 12, 13: Explosions at Oaks and Talke Collieries.

1867.—Nov. 8: Temperature rose 20°. Explosion in Glamorganshire and Silverdale, North Staffordshire. Nov. 11: Barometer fell from a very high pressure on the 9th 0·25 in. Explosion on that day at Homer's Hill, Worcestershire.

1868.—November: Barometer and thermometer in rapid fluctuation from the 19th, when the pressure was great. At 7 P.M. on the 22d the mercury was 1·49 in. lower than on the 19th. The alternate changes went on to the 26th, when the Arley Mine explosion took place.

It is not the mere reading and registration of the state of the thermometer and barometer that can do any good. You may have first-class instruments at the top and bottom of every coal pit in the kingdom, and record the results daily and even oftener if you like; but to this must be added the importance of acting on great changes, as will be demonstrated by such observations, and will lead to increasing the ventilation of the most dangerous workings of the pits by passing more air therein at such exceptional times, and, above all, by reminding the colliers in such seasons of danger to use extra precautions for their own safety, and for the protection of those around them. Few persons practically understand the importance of appreciating barometrical results more in a comparative point of view than the actual reading at the time of observations. It is not so much the height of the barometer that should be impressed on the mind of the observer as the previous stages of atmospheric pressure. Thus, on the date of the explosion at Homer Hill, the morning of Nov. 11, 1867, the mercury was high, but on the day previous the pressure had been one-fifth of an inch higher. A fall of the barometer from a high point should be looked upon as important in the winter, because great atmospheric pressure at this season is generally attended with hazy, foggy weather, which is of itself unfavourable for colliery ventilation, and a relaxation of pressure at such a period must interfere with the ventilation. When there is a rapid fall in the barometer in the winter the temperature will probably rise. The wind will be S.E., W.S.W., with rain and abundance of ozone. Sometimes the barometer will decline without either rain or wind following. In that case atmospheric depression is for a reduction of temperature, as on Dec. 31, 1863, and on the night preceding Nov. 30, 1866. A fall of the barometer with a polar wind, or from the N.E., is equal to double such a depression from the S.W., but on account of the greater evaporation from the polar current it does not affect the ventilation of coal mining so much as that from the Gulf Stream. The wind blows, on an average, from S.W. eight months in the year. A great decline of atmospheric pressure in the winter months should be watched with the utmost concern and caution by every person engaged in colliery work. In nine times out of ten the fall of the barometer will be with the wind from S.E. to S.W., and if the temperature has been low it will immediately rise. Such conditions are highly dangerous for coal mining.

Mr. Jeremiah Skidmore, jun., mining engineer, Brierley Hill, read a paper "On the South-Western Extremity of the South Staffordshire Coal Field, including the Stourbridge Fire-Clay." He reminded the members that the thick coal maintains, without any remarkable variation, its ordinary distinctness, until, starting from Dudley, the Brierley Hill fault is reached. This fault forms a downthrow to the south of some 80 yards. On the deep side of the fault a considerable change begins to occur. The stratifications become materially altered; large masses of rock and spoil interpose the coal seams and tend to interfere in no small degree with the ordinary method of working, and greater danger and liability to accidents is experienced. The quality of the coal is deteriorated, and a considerable disadvantage to the proprietors in a pecuniary point of view, are some of the consequent results. This state of things continues to exist until another huge fault is reached, which is an upthrow to the south of some 60 yards in the middle of its range, but decreases in magnitude towards its extremities. This fault, and the one just previously referred to, constitute what are termed the Level Trough faults. These pair of faults have their origin in the Great Western Boundary fault, and run at an oblique angle from west to east, widening in their distance apart eastward until they coalesce in the Netherton Anteclinal. The collieries situate between these faults, or that are in the Trough, are the greater portion of High Areal, part of Moor Lane (Col. Atkinson's), Chapel Hill. The Nine Locks and Robin Hood; and, in addition to the fractured and inferior character of the thick coal, there is the further significant disadvantage of being no bottom mines, neither heathen coal, white-stone, or fire-clay that are workable at all. On and from the crop side of the second fault above described, throughout the remaining portion of the coal field south-westward, the greatest confusion and irregularity exist. The distinctive features of the thick coal in places are completely lost. The coal becomes greatly deteriorated in quality, value, and character, and is split up, dislocated, and interstratified alternately with immense masses of slummy, smuthy, batty, and rocky material, which necessitates at some places two, three, and even four separate workings. To enumerate some of the peculiarities attending this fag-end of the great coal district, we have at Brettle Lane, in the collieries approximate to the Western Boundary fault, 7 ft. of spoil, on what is termed the bottom coal, which consists of the Slipper, Sawyer, and Patchell's; 16 ft. on the Stone coal, and 30 ft. on the Heath coal. The coal here is divided into four separate sections, which combined give the usual thickness of 30 ft., but are found occupying 83 ft. of measures. At the Delph we have 6 yards of rock on the fine coal, and 6 ft. of spoil interposing the other seams. At Tintain Abbey, still southward, we have 5 ft. of spoil on the bottom coal, and 5 ft. on the middle coal, a remarkable feature here being that the total thickness of the coals so separated are but 19 ft., thus showing a thinning and diminution in the coal itself, and not by a mere separation of the coals by additional intermixtures of spoil. At the Lye we experience still greater peculiarity in the stratifications of the measures. Here we have 9 ft. of spoil interposing between the bottom and middle coals, and 33 ft. between the middle and top, 9 ft. of which are composed of what are locally termed white ironstone measures, and 24 ft. of chance rock, the total thicknesses of the coals being but 19 ft., and occupy a thickness of 60 ft. of measures. As we go still southward from the Lye the stratifications of the measures become more irregular, and there is a growing deterioration in the quality and value of the coal; and, as it dips off at a considerable angle, no one has cared as yet to trace its extreme limit in that direction. In other portions of the district under notice no coal measures at all exist, and the fire-clay, whose definite position is some 20 yards beneath the thick coal, is found in close proximity to the surface; and this brings me to remark that if the south-western extremity of the coal field has suffered a material disadvantage, so far as its coal formations and resources are concerned, such have been amply compensated for by the possession of a treasure of far greater value than the most choice quality of thick coal that could have occupied the same area. A great part of the district I have been describing has held possession of the richest quality of the celebrated Stourbridge fire-clay, a clay which has long been held in repute as possessing great superiority of quality and value over other fire-clays, and has rendered the town and district by which it is designated, and in which it is contained, celebrated throughout the commercial world. The depth of this clay throughout the present Stourbridge district ranges from 10 to 200 yards, and it is somewhat remarkable that the beds containing the greatest amount, or percentage, of best pot-clay (which is the choicest and most valuable part) have been discovered in those parts of the district where the thick coal has been either of the most inferior quality, or where little or none has been found to exist, owing to the cropping-off, or over-shooting, of all the coal and other measures. I am not sufficiently acquainted with the laws of attraction to explain how or why this should be so. But it is, nevertheless, certain that the quantity, or proportion, of superior parts which have been extracted at these particular places have been such as to render or place the value of a yard or acre much beyond what may be termed the average value, or ordinary value, and to far more than compensate for the inferiority or non-existence of coal. The chief and certainly the most important characteristic belonging to the Stourbridge fire-clay is its refractoriness, resisting the action of fire in proportion to its almost perfect freedom from alkaline earths and iron, substances which render inferior clay fusible at high temperatures. A cubic yard will yield 37½ cwts., and in certain portions of the district the same quantity has been known to give a percentage of from 15 to 20 cwts. of best clay per yard. Instance the Lunt and the Freehold Estates. Such a production as this bespeaks a most rich and valuable mine, and when those two estates were in vigorous work best pot-clay realised from 4*l.* 10*s.* to 5*l.* per ton. But only in a very limited degree can anything approaching this be said of the mines in operation at the present day. The yield of best may now be taken as ranging from 2 to 10 cwts. per yard. This clay in the shallowest parts of the district has to be worked or gotten by a continuation of stalls, of from 3 to 10 yards in width, as its close proximity to the surface renders it impracticable, from want of sufficient bearing, to work it by the ordinary long wall system. Where it is situated in the deeper parts, and will admit of being worked by that system, immense quantities of timber have to be used, in order to maintain the roads and roof, and to support the great weight of superincumbent strata which, in process of working, becomes dislocated and unlocked from the bottom rock. This has the effect of damaging, destroying, and rendering stationary a great proportion of the timber so used, which, in consequence, becomes a very considerable item in the cost of getting. From the earliest period of fire-clay getting in this district it has been a custom for the men to work but eight hours per day, commencing at 8 o'clock in the morning, and discontinuing at 4 o'clock in the afternoon. This usage is said to have originated in the alleged injurious effects which the working in this mine has upon the men employed in it. Whether this be the rightful origin, or whether the custom on the ground stated is indispensable or not, the men, I can assure you, have no other intention than to keep up such custom in full and vigorous force. Up to within some 15 or 20 years the Stourbridge district of fire-clay was limited to the Lye and its surrounding vicinities, comprising the New Farm, Stamber Mill, Amblecote, Ravensitch, Mousehall, and Tintain Abbey. But the greater portion of this, the old district, is now well nigh exhausted, and excepting the Earl of Dudley (who has still a considerable quantity), and the Earl of Stamford and Warrington, few proprietors have any left in a maiden state. But explorations from this once confined district are extending in various directions. Eastward a new basin is in course of development, of which the Hayes is the extreme crop, and Old Hill the extreme deep. The resources of this district are comparatively unlimited. Westward the great western fault is the boundary, and thence north as far as Brettle Lane, where one of the level trough faults are reached. It afterwards, at Mount Pleasant, coalesces with the Netherton anticlinal, which forms the boundary of the clay on the north. Southward it is doubtful, and its limits unknown. With its coal and its clay resources, this district has tended, and still continues, to form a material and valuable link in the commercial resources of our great and enterprising country.

Mr. William Blakemore, mining engineer, of New Cross, Wednesfield, then read a paper entitled "A few Remarks on Coal." The paper, he said, had been written amid the care and hurry of business, during the previous few days, at the request of their hon. secretary. He remarked, first, upon the three different kinds of coal; second, upon the uses of coal; and, third, upon the consumption of coal. The present consumption, he said, is astounding, when compared with what it was a few years ago. Whether we look at our shipments for home or foreign markets, at our consumption for smelting, manufacturing, or domestic purposes, the increase is enormous. After showing that the annual output of 40,000,000 tons 20 years ago had risen to 104,500,000 tons in 1867, the author said—This rapid increase of consumption has excited the fears of some of our fellow-countrymen, and has aroused a spirit of enquiry as to the supply of coal in the future. This brings me to my last remark, which is on the exhaustion of coal. Some of the most eminent men of the country have recently turned their attention to the probable extent and duration of our coal fields. Sir Roderick Murchison referred to this question before the British Association in 1865 and 1866. The present Premier spoke of it in the House of Commons, the result of which was the appointment of a Royal Commission, to take stock of the probable quantity of ungotten coal in these realms. It would be premature to venture an opinion on this grave question during the progress of the enquiry. When it is completed, we are of opinion that the burden of the Commissioners' report will be calculated to allay any forebodings that might have been created by the remarks of Mr. Edward Hull, Mr. W. Stanley Jevons, Mr. Robert Hunt, and Sir William Armstrong. Although the annual output of coal in Great Britain is prodigious, yet it is comparatively small when contrasted with the bulk that is still entombed in our subterranean domains, the weight of which will surpass any computation that the writer has hitherto seen. There are, doubtless, thousands of acres in the great coal basin of South Wales, in North Wales, and Shropshire, of which very little is known at present, but which will, in after years, as the exhaustion of other coal fields goes on, be explored and won to meet future demands. The future supply of coal in South Staffordshire is a question which more immediately concerns us who are

assembled here to-day; and, though coal has been worked in this district for more than 20 years, I am disposed to the belief that it will not be completely exhausted during the next century at our present output of 10,000,000 tons per annum. I am aware that many collieries in the centre of this coal field are partially worked out, and I may be asked—Where is the supply to come from? My reply is that, with advanced mine experience, perfect knowledge of chemistry, and greater mining scientific skill, the millions of tons of inferior coal which have been abandoned, and now lie buried, will hereafter be wrought and utilised. I now refer more particularly to the large quantity of "black coal," which is so peculiar to this district, and also to those other inferior coals which a better quality has hitherto kept out of the market. And I may also refer to the undeveloped thousands of acres of mineral property in the northern extremity of this coal field. I may be permitted to say that some time ago I had the honour of preparing some mineral statistics for a Committee of the House of Commons relative to this portion of our district, and I calculated that it would take 130 years to exhaust that part of the district of which I made a return at the present rate of get. And I think, gentlemen, that we may safely congratulate ourselves that we shall not be starved out for the want of this valuable fuel during the next generation. And now, in conclusion, allow me to say that we may see how much, as a community we are dependent upon our coal for national prosperity and greatness, and that it largely contributes to the comfort and well being of thousands of our fellow-men by whom we are surrounded. It behoves us, therefore, as an Association to whom is entrusted the management and supervision of miners, and the working and winning of mines—first, to unite for the purpose of stimulating each other in the pursuit of practical and scientific knowledge, by which we shall be best enabled to work our mines to the greatest profit with the least waste, and least risk of human life; and, second, to aid and support by our sympathy, our influence, and our pockets all those institutions which have for their object the moral, mental, and social improvement of the mining population of this district. And, gentlemen, if we make these motives the basis of our action, and the end of our efforts, we shall no fail to secure the help and good wishes of coal owners and ironmasters in particular, and the public in general; and, then, we shall be able to smile at those persons (if there be any) who may be tempted to snort scorn at an institution of this sort. (Applause.)

The HON. SECRETARY then explained that Mr. HENRY BECKETT had contributed, at his request, a paper "On the Proposed Franco-British Tunnel," which, as also a contribution by Mr. LOBLEY, on "The Vesuvius Drawings," he hoped they might find time to read at their next gathering. Even before that time he hoped to be able to have for their use and inspection, and if necessary trial, in that room one of Mr. Bidder's improved coal-breaking machines.

The meeting, which had been most successful throughout, then terminated, and the members and their friends dined together.

After dinner, "The Coal Trade" and some other toasts were given, and responded to with much heartiness, and the President, the Hon. Secretary, and the readers of papers were all warmly complimented.

The Royal School of Mines, Jermyn Street.

MR. WARINGTON SMYTH'S LECTURES.

[FROM NOTES BY OUR OWN REPORTER.]

LECTURE XVIII.—In the last lecture (said Mr. SMYTH) I brought before you the means employed and the implements used for the purposes of boring when blasting is to be carried on; and I mentioned that the greatest improvement of modern times had been the selection of more suitable materials—cast steel, instead of the borer formerly used of iron, with a steel cutter; and I pointed out that during the operation of boring there is, of course, no risk, except in what occurs from an unskilful borer making a false blow, but that the danger which is so great in the use of explosives commences when the explosive material is placed in the bore-hole. Before, however, we came to that part of the subject the question was suggested to us whether or not the laborious operations in which we have to employ so many men might not be re-placed by some simple kind of machinery. At first sight anyone might think there would be no difficulty in doing that; and it is only those who try who discover what the difficulty is. Ingenuity, however, has been rife in respect to this same idea, and machines almost without number have been proposed; some to take out the entire drift by tunnelling, or portions of it by blasting. With respect to those machines used for tunnelling, not one has been attended with complete success, the greater part being the most palpable failures, because they have determined to avail themselves only of the power of steam or compressed air, and discarded the aid of explosives. They have thrown away the enormous advantage which gunpowder would bring to bear; and inasmuch as the cutting power they employ is often directed against hard quartzose rocks, the wear and tear is so considerable that no machine as yet brought forward has had more than a moderate amount of success. I do not propose to-day to mention any of these proposed machines, except those which have been actually employed and are in use. The case, however, is far different as regards machines for boring holes for the lodgment of gunpowder, which have made great advances during the last eight years. There was a great variety shown at the Exhibition at Paris; and, so far as drilling holes may go, that exhibited by the engineers of one of the great lines of continental railway (M. Leschot) was one of the most interesting. He proposed a borer, of which one extremity should be a ring, on which should be mounted a number of pieces of diamond; and this ring, at the extremity of a boring rod, is pressed against the rock to be bored, and made to revolve with great rapidity. The excessive hardness of the diamond cuts in this way the hardest rocks, and the only question remaining is that of economy. The variety of this machine, introduced by M. de la Roche Tolet, who applies in a beautifully ingenious manner hydraulic power, which keeps up a constant pressure of 1500 or 1600 lbs. to the inch; and the borer being tubular, a stream of water is kept incessantly playing on the face of the boring, and so leaves it clean and clear for the action of the diamond, the tube also bringing out the centre of the piece cut in the shape of a core. The number of revolutions per minute is large, and by this implement bore-holes can be made at an exceedingly rapid rate. The quantity of diamond worn away is insignificant, and the cost of it cannot, therefore, be regarded as too expensive. The stone used is that peculiar kind called "black diamond," which is not used for ornament, but it has the hardness of the ordinary transparent diamond. The fragments are securely set in soft iron, and when no longer capable of use may be sold for diamond dust, which is much used in the work of the lapidary. It is stated that one hole of 20 in. deep costs rather less than 2d. as regards the expenditure of diamond. I do not know, however, that the machine has been used in underground mining, but it has done good service in boring railway tunnels.*

Another machine, contrived by M. Schmann, at Freiberg, might have suggested that of M. Sommallier, used at a great tunnel under Mont Cenis. It was placed there at the end of the year 1861, and has been working ever since on a large scale with a great degree of success, being a machine capable of doing an enormous amount of work in a certain class of excavations, but not capable of being applied to mining purposes. It must be recollected that at Mont Cenis the apparatus is placed at one extremity of the tunnel, and the machinery for producing the compressed air with which it is worked has cost no less than from 30,000*l.* to 40,000*l.*, and, taking both ends of the tunnel, that is an outlay quite incompatible with ordinary mining. It is an outlay fitted only for a great national work like this—connecting the railway systems of two great countries, by making a passage through a formidable mountain range. I had lately the advantage of being conducted by the engineer through the whole of the workings on the north side, and of carefully examining the machinery employed; and it is surprising how ingenious, in the first instance, was the idea, and how well it has been carried out. At the time I visited the place the forebreast had advanced two miles into the mountain, and no outlet by way of a shaft for ventilation possible. From the outset ventilation had to be procured from the entrance, and the drift being no more than 7 ft. square, the machine fits it so nearly that the men had but just room to squeeze themselves by main force past its sides, and for two or three men on the top. The noise it makes is so deafening that it is impossible to hear the loudest sound, and I could ask no questions, and learn no more while there than I could see of what was going on. The machines employed are of the same general character as those introduced by M. Dœring into Belgium, Prussia, and this country, and M. Bergsten into Sweden. They each have a cylinder, fitted with side valves, by which compressed air is admitted alternately, and thus working the piston, to which is attached a boring tool of the ordinary length for the stroke, 150 to 200 blows per minute are given. It turns slightly at every blow, just as the ordinary "jumper" has to be turned. A curious kind of "bit" is used, the edge being shaped somewhat thus, Z. A singular fact has been noticed in reference to this implement. The same bit in the same class of rock is found to last five times as long when worked by a machine as it does when worked by hand. The reason of this probably is that the great rapidity and equality of the stroke affects the metal less than unequal heavy blows from a great double-handed mallet. Furthermore, at the Mont Cenis tunnel the eight or ten borers there worked exhibit the same economy; and, perhaps, I ought to mention, as showing the enormous power of this machine, that in the hardest quartz rocks upwards of 1000 yards have been driven at the rate of 60 ft. in a month in some cases, and when they have been at work in clay-slate they have advanced 6¼ ft. in a single day. All the details have elaborated by degrees and with great care under the most efficient engineers, who, being backed and supported by Government aid and influence, have had every chance for the development of their inventive ability and powers of ingenious adaptability. I need not go into the machinery for compressing the air, which involves a great amount of clever contrivance, as it is placed at a great and an increasing distance from the work. The difficulties to be overcome from this circumstance will be obvious if we consider what would happen if with so simple a contrivance as a water-wheel we had it placed at a distance of half-a-mile from the work; but at Mont Cenis the compressed air machine is more than two miles off, and there is so great a loss of power that a force of 7 or 7½ atmospheres only exerts at the boring-machine the power of about 4½ atmospheres.

A machine not very dissimilar in general features is (as I have mentioned) that of M. Dœring, but he has preferred to take a single cylinder. It is mounted on wheels, and so is conveyed to the face of the workings, while the borer is arranged so as to act either up or downward, or obliquely. This machine has had a pretty long trial at the Vieille Montagne Mines, and is there so much approved that the managers have had eleven of them made. The workmen there have to deal with a tolerably hard rock, and I have been credibly informed that whereas driving through a mass of dolomite the advance made by six men was 5 ft. in a fortnight, that made with the machine and two men was 10 ft. in the same time, so that the advantage gained was considerable. Several of these machines were exhibited last year at the Polytechnic Exhibition in Cornwall, and during last summer I took an opportunity of going to see one at work at a Cornish mine, called Tincroft, where I found that after several changes, which were deemed necessary in getting it to work, it was in full operation, with a good effect being produced of a decided success. Although the machine was exhibited here in London, making holes in blocks of granite, M. Dœring had no idea of what a really hard rock was until he descended to the 180 fm. level in the Tincroft Mine, and saw how hard a capelly tin lode could be; and he had to make several alterations in the machine, which now is said to be quite equal to the work. In applying machines of this kind to metallic mining, great difficulties will often be presented by the great distance the compressed air has to be conveyed from the steam-engine at the surface. In this mine the distance was 2000 ft., and the air compressed to 25 lbs. to the inch at the surface, was found (having passed along common gas pipes 2 in. in diameter) to be reduced to 20 lbs. to the inch; but, nevertheless, the work was well done on an excessively hard rock with that lowered pressure. The expense is not so serious as that it cannot be undertaken by any mining company, and the cost of a compressing engine is also moderate, but it requires a considerable amount of care in its application. The Cornish miners, however, have managed the machine with success, and express themselves favourably as to the amount of work it will do. A machine, invented by M. Bergsten, has also been successfully worked at Persberg, where it had not anything like the advantages given in the Vieille Montagne Mines. Its peculiarity is that it has a lever arrangement, by which it is wedged up between the roof and the floor; and so obviously could not be used where either were of a soft or yielding nature. As a general statement, it may be said, with regard to metalliferous mines, that the prospects of machines which propose to cut away the rock bodily without explosions are not encouraging, but those which make bore-holes, and bring in gunpowder, have a good chance of success.

We will now pass to certain other points, and, first, that of charging and preparing the hole for firing. When the ground is vughy, or cavernous, the effect of an explosion will be lost by the force being disseminated through the hollows, and every miner knows in such rocks so much progress will not be made by two or three charges as by one in those which are tolerably compact. The quality of the powder employed is, therefore, of importance. That generally used is called "blasting powder," which is coarse grained, and generally glazed, although in the last few years persons have set themselves to work to improve upon it, and the result is that there are now patented blasting powders of various kinds, of which it is difficult to say which is the best. Up to the last few years gun-cotton was much used in some districts, and with the improvements of Messrs. Prentice, of Stow Market, who prepare it in ropes, so that it can be cut off in convenient lengths, just suitable for particular classes of bore-holes. Another important explosive is Nobel's patent blasting oil, or nitro-glycerine, but the terrible accidents which have taken place from nitro-glycerine have so terrified the mining population as to prevent its application on any considerable scale. It is, however, used at Persberg, and elsewhere in Sweden and in Norway, where its advantage over gunpowder is reckoned at 80 per cent. as regards force, and 50 per cent. as regards the speed and economy of the operation. This is chiefly because it does not require the ordinary processes of tamping with clay, &c., as all that is necessary is to pour the nitro-glycerine into the hole, and its specific gravity being greater than that of water it remains at the bottom, and is fired with enormous effect without tamping, as its instantaneous explosive force greatly exceeds that of gunpowder. The water serving for tamping saves a great amount of time. The extremely incautious manner in which nitro-glycerine has been used, and the sad results which have ensued, have led to its preparation in the form of a greyish powder, called "dynamite," which has the same explosive power when fired in a proper manner—that is, not by means of an increased temperature, but by some kind of concussion. Thus a little dynamite might be fired on a piece of paper on this table and do no harm, but if fired by percussion it would blow this building to pieces. Mr. Abel, director of the laboratory at the Woolwich Arsenal, who has made so many important experiments upon explosive materials, has discovered that gun-cotton will produce much greater results when fired by means of a large detonating cap than when fired by ordinary means, and it is now an interesting question whether gunpowder does not follow the same law. A tunnel in America is said to have by the aid of dynamite been driven in half the time it would have required if only gunpowder had been used.

With reference to the charging of the hole a few simple rules only are necessary. If the hole be dry the powder is introduced loose, by a sort of spoon at the end of a tamping-needle, and great care must be taken not to leave any grains of powder along the bore-hole. On the powder is placed a wad or plug, which may be made of wood, tow, or paper, and to make a way for the fuse what is called a shooting-needle is employed, which should be made of copper; but I am very sorry to say that, in order to save a trifle of expense, it is commonly constructed of iron. The result is that in drawing it out the iron, coming upon a stone in the bore-hole, gives a spark, which prematurely fires the charge, and thus it is the prolific source of accidents, and the loss of the eyes, if not the lives, of the workmen. The tamping is then put in. In the early days of blasting an apparatus was used called core and arrows, and it is now used in some granite quarries. The object of tamping is, of course, to make the resistance greater in the bore-hole than in the material at the sides of the bottom of the hole where the charge is placed. When Napoleon I. crossed the Alps, passages through the rocks often had to be cut for the artillery and baggage-wagons, and the engineers in blasting for this purpose discovered that dry sand made very good tamping. In some way, the particles being loose, the force is delayed amongst them long enough to allow the shot to take effect below the sand, and thus blow down the mass sought to be dislodged. If the sand were wet or solidified by pressure it only acted as the wadding of a gun, and was simply blown out, without producing any effect on the rock. The best tamping, however, there is no doubt is well-tempered clay. Through this the tamping-bar is hammered down to the charge, in order to introduce the fuse, and here arises a fertile source of accidents, but one which it would be easy to avoid. If anything of a quartzose or gritty character be in the tamping the bar, if of iron, is almost sure to ignite the charge. It was proposed long ago by a benevolent physician, Dr. Paris, to tip the end of the tamping-bar with bronze, which would give a perfect immunity from such accidents, but the little additional expense it involves often prevents the adoption of this expedient. The fuses used were formerly of the most simple kind, as, for instance, a stiff straw, loaded with fine sporting powder, was placed at the orifice left by the needle, or a tube of goose quills, one fitting into another, until the required length was attained. Some years ago the safety-fuse was invented, and so great an amount of safety and convenience was thereby gained that the use of it has become all but universal. [The lecturer concluded by exhibiting the modes of firing the safety-fuse, and demonstrating by an experiment that it would act with certainty even where it passed through water.]

LECTURE XIX.—In the last lecture I brought before you some of the details of boring for blasting rocks, and remarked upon some of the facts relating to new kinds of explosive materials now coming into use in certain localities. I mentioned more particularly the interesting discovery of Prof. Abel, that besides dynamite and nitro-glycerine, other explosive materials are capable of being exploded with much greater force by the use of percussion than by the ordinary system of ignition. And I should premise now, before proceeding to certain other subjects connected with blasting, a few matters relating to the direction in which the lode ought to be bored, a proper appreciation of which nothing but actual practice can bring home to us, so as to avail ourselves of the various complicated considerations which have to come before the miner. A few points, however, will be almost self-evident. The first thing is to determine "the line of least resistance," or the direction in which the powder will take the greatest effect. This is generally, in a military mine, a vertical line, reaching from the centre of the charge to the surface, or the shortest line to the open air, and the charge is proportioned according to the ratio of the cubes of the lines of least resistance. But when we come to mining, the line of least resistance is not always the shortest. The different characters of rocks, the fissures in them, and other circumstances, are so multifarious as to vary that line; and it is often a difficult point to determine how to fix the bore-hole so as to bring down the largest quantity of material. Except in certain rare cases of homogeneous ground, there are sure to be joints or cleavage or cracks, and even in metalliferous veins, when there is no distinct stratification, there is often a tendency to crop joints or "queers," as they are called. Suppose these joints are dipping towards you, it is clear that they will greatly assist the operation of blasting, and, therefore, the charge must be put in so as to blow out a little nick across the bottom, and then proceed to put in bore-holes at the top, which, in succession, will take out small proportions of the rocks with great advantage. Experience alone can be the guide as to suiting the direction of the bore-hole to the direction of these "queers," and the miners generally, although in different degrees, will be found competent to deal with these questions, so as not to throw away a shot. This is important, because in very cavernous rocks the powder may blow away, as it is termed, into the cavities without producing an appreciable or proper effect.

Mr. Smyth then, by means of diagrams, showed a great diversity of circumstances in which the bore-holes were to be made deeper or shallower, or inclined at more or less acute angles. Experience had shown that, under certain conditions, one bore-hole sunk as deep as two shallow ones put together will produce more than double the effect of the two. As long as the charges of powder are small—as, for instance, 2 or 3 ozs.—economy in their use does not seem to be of much consequence; but that is a most important consideration in large charges and single holes are employed. Thus, at the top of a quarry where there may be 40 ft. of over matter to take off as waste, holes as deep as 8 ft. are bored, and large blasts are put in. It is in such cases that large charges are found to be an enormous gain, and during the last 25 years some remarkable operations have been carried out in this way. Amongst these might be mentioned the case of the Royal George, which was accidentally sunk at Spithead in the last century. Franklin long ago proved the possibility of firing gunpowder by the electric spark, and Sir C. Pasley, having by means of divers skilfully placed certain charges of gunpowder in the wreck, succeeded in exploding them by a galvanic battery. Another remarkable case was that in which large masses of chalk in the neighbourhood of Dover were blown down for railway purposes. This system of firing has long been practised with economy and success in large operations, whether at the surface or in actual mining. A few years ago a large oval shaft, 22 feet across at its widest part, had this mode of blasting applied to it with great effect. Bore-holes 2¼ or 3 inches in diameter were made at suitable points, and charged with small cartridges, which, by means of electricity, were fired simultaneously. One of the greatest sources of danger in ordinary blasting arises from the charge not exploding at the moment it is expected, either from some defect in the fuse itself, or the manner in which it is placed; and the miner, going to find out the cause, arrives just at the moment when the delayed explosion takes place, and loses his life, or is maimed for life. To obviate this danger it has been proposed to employ electricity, and several very conveniently arranged batteries for use in mines have been devised at moderate prices. [Mr. Smyth here exhibited several electro-magnetic machines of this class.] The mode of firing cartridges by this means is very simple. Two extremities of the wires, connected with the negative and positive poles, are enclosed in a small tube, showing between their end a thin platinum wire (which becomes strongly heated when the current of electricity is made to pass), together with some fine sporting powder, and this being in the middle of the charge the explosion follows with unerring certainty.

The explosive force of gunpowder has been the subject of much experiment, particularly by military engineers, and they have determined pretty accurately the exact effect produced in a certain class of ground by a given charge of powder; but when the object is to remove blocks from their beds, for the purposes of forming a breakwater, like that at Holyhead, it has been found that much larger charges are required. Thus, if we take the line of least resistance to be 6 ft., and find by experiment that 22 lbs. of powder are required to produce a given effect, as in the Dover case, the rock being of chalk or rubble, then a 7-ft. line of resistance will require 35 lbs. $(6^3 : 22 :: 7^3 : 35)$. In the same way, if the line of resistance were 12 ft., the charge will not be double that at 6 ft., but as the cube of 6 to 22 lbs.; so that the cube of 12 will be to a result of 176 lbs. $(6^3 : 22 :: 12^3 : 176)$. The increase, therefore, of the charge is extremely rapid. It is unnecessary to give a long series of these illustrations, of which a great number are recorded, and I now proceed to say a few words on the system of fire-setting, by means of which large masses of rock are brought down without the aid of gunpowder. There is no doubt that fire-setting was practiced by the Romans, as in some of the classic authors there are accounts of their having caused the stones to crack and separate by means of great piles of wood set on fire. It is not, however, now employed in mining, except in certain continental districts, where the rock is of extraordinary hardness, as, for instance, at the Rammelsberg Mines, in the Hartz, in Norway and Sweden, and in Hungary. In the Hartz systematically arranged piles of wood are heaped against the face of the workings (which are something like our long wall system), generally on a Saturday night, and fired. In half-an-hour after the heat becomes fairly operative small explosions begin to be heard, and the rock comes down in large flakes. By Monday or Tuesday morning the workings are comparatively cool, and the miners often find as much rock displaced or fissured as will occupy them two or three days in removal. By this means rocks which would scarcely yield at all to ordinary methods of attack are worked with great economy in these countries, where, however, it must be borne in mind that fuel is exceedingly cheap and abundant. In Transylvania levels are actually driven by means of this process, but it often leaves vast masses of roof in an insecure state, and such a mode of treating even the hard rocks in which the levels are run must be a constant source of danger, requiring the greatest care and circumspection on the part of the miners.

* We are informed that a shaft, expected to be 900 yards deep, is in the course of sinking at Croeser, near Port Madoc, at which one of these diamond borers is used with great advantage, both as regards speed and efficiency. It is manufactured by Appleby Brothers, of Southwark Bridge, and claims to be an improvement on the French patent, by the introduction of India rubber springs and in other respects.

Original Correspondence.

THE STEAM-ENGINE—PATENTS AND IMPROVEMENTS.

HOW INVENTORS ARE TREATED BY ENGINEERING WRITERS AND OTHERS.

SIR,—You will much oblige me by giving insertion to the following letter. I commence it by an extract from the paper of Messrs. Normand and Mallet, on French Marine Engines. After much preliminary matter, we come to the following:—

"Rowan and Horton, about 1856, built marine-engines on Woof's plan, with surface condensers; they tried high pressures, 8 to 9 atmospheres. In spite of a considerable degree of expansion, these engines, as applied to a screw, were of moderate dimensions. Difficulties in practice, caused mainly by the high pressure, have limited the application of these engines, but the fact cannot be ignored that they have largely helped the simplification of the question, in proving *by facts* the possibility of reducing to 1 kilogramme (2·2 lbs.) per indicated horse power the consumption of fuel in a marine-engine of moderate size."

"With ideas better directed, Randolph and Elder have sought an increase of expansion without increasing the boiler pressure, but by considerably enlarging the capacity of the cylinders."

The above, with the following table, is taken from Normand and Mallet's paper:—

	Total volume compared with the volume of admission.	Proportional utilisation.
Old style of marine-engines	1½	1·00
Depuy de Lome	2⅓	1·30
Normand	4½	1·60
Humphry's	6	1·74
Rowan and Horton	8	1·84
Randolph and Elder	10	1·90

We are also informed by this paper that Normand's new system (which consists in an intervening steam-chest between the high and low pressure cylinders, the steam on passing through it being superheated before entering the low pressure cylinder) was first used in 1860, and that by it he has now reduced the coal per indicated horse-power to 2·42 lbs. This is the same thing as forms the subject of Cowper's patent, obtained, I think, in 1862. In the *Mining Journal* of June 1, 1867, you published extracts from the manuscript pamphlet I had previously placed in your hands; following its publication appeared a letter, signed "Engineer," which is found in the *Mining Journal* of June 15, 1867. To the questions raised in that letter, one from me, which I think appeared in the Journal in two or three weeks afterwards, dealt chiefly with what constitutes the basis of my invention; but also referred your correspondent to recorded evidence relating to the structural parts which are mine, and by which I kept this basis producing steam power for 18 years, at such small cost in coal per horse-power per hour as to have reduced it to 1 lb. per indicated horse-power per hour. At this point you, Sir, I have no doubt, are well aware that Rankin's experiments, which as they were of only one hour's duration, are objected to, and mine, though conducted for weeks together, are set at naught, because I suppose I am considered as not entitled to the justice which all other human beings have received, though after 20 years as engineer and inventor I established such a combination of principles, and embodied them in all the best mechanical structures, as reduced the coal from 16 lbs. to 1 lb., or from 8 lbs. to 1 lb., reducing at the same time the size and weight of the structural parts considerably below anything which even the non-condensing engine had previously attained. In addition to this, by your aid and that of others, a thorough knowledge of all this was published to nearly all the engineering world on my part, by months of hard study at intervals through those 20 years, in which practical results, and not theories, form the bases in all cases of such information as was then given by me. This study was rendered much greater by the fact that circumstances compelled me to convey much practical knowledge in the fewest words by which I could render the subjects clear. After all this, I suppose I must be something below a dog, as no dog would be so treated by educated persons as such persons have treated me.

Your correspondent, "Engineer," asks me to assert I did this and that: assertions are easily made, but barely as such I hold them of little value. Therefore, when made the directions will follow to records which now are historic, by which the assertions can be compared, and their truth or falsehood determined. Upon my specification of 1840, No. 8432, I assert that in addition to condensing the steam by air or water, and the generation of high-pressure steam in tubular boilers, it is clearly seen that I conveyed the hot gases, or product of combustion, over the outside of the single, in that case, steam-cylinders, on their way to the chimney. I also assert that there the feed water is represented as being heated on its way to the boiler. There, also, it is clearly seen that the hot gases act upon the steam above the water level in the boiler, which from first to last was always the case with my boilers in practice. I assert that in 1841 and 1842 I used the single cylinder with the steam cut off in it, as far as I now remember, at a quarter of the stroke. I assert that I generated the steam then in the common boiler at from 30 lbs. to 50 lbs. pressure per square inch. I assert that I condensed this steam by the atmosphere, that I got 16 in. of vacuum, as it was then expressed, and that I retained the steam water. I assert that I worked that engine and boiler for four consecutive weeks with no water added from the first day until the last of the four weeks, and that the loss per day in water was one gallon per horse-power. The verification of the above assertions is found in the "Mechanics' Magazine" of March 26, 1842, page 246, and elsewhere among my communications to the public in those early years.

The following assertions are found verified by referring to the "Mechanics' Magazine," from March 11, 1843, pages 76, 245, and 546. I assert that this engine was the first of the double-cylinder direct-acting class that was ever set to work, or that the public had any knowledge of, and that with this engine, and the use of steam at 100 lbs. pressure, I got a steady vacuum of 12 lbs. in my atmospheric condenser, and reduced the coal in such engine from 16 lbs. to 3 per horse-power per hour, the engine doing 25-horse power, and worked seven years. I can assert that here is the origin of its property value, as from this date the direct-acting double-cylinder engine has become a property, the purchase-money for which that has been paid into the Patent Office amounts to many thousand pounds, and the best farm in Engand has not had more expended upon its cultivation than has this direct-acting double-cylinder engine. Nor is there a farm in England which is capable of returning anything like so great an annual value upon the yearly outlay. I assert that this is the first double-cylinder engine that ever was set to work with its cranks set at angles which admitted of there being one in advance of the other, and that the result is recorded for the use of mankind. I assert that in this engine we have with the nozzel-boxes the idea of the intermediate steam chest of Normand and Cowper; and I assert that on carrying this idea in the mind to the letter, found March 25, 1843, and page 245, of the "Mechanics' Magazine," that it is there seen I left but little for Normand, Cowper, or anyone else, to do in the direction they have gone. I assert that in this letter (page 245) that in place of the two cylinders four cylinders are placed before the reader. The first of these cylinders, receiving steam from the boiler at 120 lbs., there it works at full pressure; it quits it and passes to a steam-chest, from which it goes to a cylinder double the size of the first cylinder, and quits it at 60 lbs. for a second steam-chest, from which it proceeds at 30 lbs. to a third steam cylinder of fourfold the capacity of the first. Leaving this third cylinder, it passes to a third steam-chest at 15 lbs. pressure, and into the fourth cylinder of eightfold the capacity of the first. This last cylinder is represented as connected with condenser and vacuum, and a demonstration is thus presented of the saving of coal that thus expanding the steam would effect. It is also made to show how the regular action could thus be secured to the same extent as if the steam was let out into the atmosphere when it quitted the first cylinder, as at that day it was said that such a degree of expansion was impractical, on account of the irregular motion it would produce in the engine. But, further, these three steam-chests and their steam are represented as superheated by the products of combustion being carried round the steam-chests before passing to the chimney. When readers will do to me as they do to others they will see all the elements of this kind of engine, even to the use of four cylinders, presented for the Dawing Office in practical idea.

From this point let the readers go to your Journal of June 15, 1844, page 206; they can also turn to the "Artizan" of May, 1844, page 104, and see what Bourne thought proper to insert in it; my reply should have appeared in the "Artizan" of June, but was refused insertion.

Now pass on to 1845, 1846, and 1847; for this period see the *Mining Journal*, also Bradshaw's "Railway Gazette" of 1846, see also "Mechanics' Magazine" of 1847, pages 98, 123, 156, 170, 266, 446, 308, and 380; and my lectures, with tables, and ten large sheets of drawings, published by Simpkin and Marshall, London, and there the following assertions are verified. At this time I assert I had a right to claim as my invention the angular set double-cylinder direct-acting engine, when used in the direct-acting way, or as the oscillating engine in all the varieties of ways which the principle admits of; and I assert the claim is there broadly and clearly stated in relation to those two modifications; out of the three modes, and be it here noted that the words *three modifications* include all the possible ways of using the twin direct-acting double-cylinder engine, except two other ways, both of which were made by me in 1845, the one substantially is that used afterwards by Humphrys as a direct-acting engine, and by Sims also. This engine had the low-pressure cylinder above the cross-head, and the high-pressure cylinder below the cross-head, the both piston-rods coupling to the cross-head by the same cutter, the low-pressure piston-rod for this purpose being bored out to receive the end of the high-pressure piston-rod in that part of both ends that connects to the cross-head, from which it is easy to see how the one cutter, which holds both piston-

rods and cross-head together, effected the object. The connecting-rod was composed of two side rods, one going on either side of the high-pressure cylinder, and being connected to another cross-head, from which projected the strap end that coupled to the crank-pin, the both cylinders being above the crank-shaft, the low, of course, inverted, and the high-pressure the reverse. I then adopted this mode in preference to employing a metallic stuffing-box between the two cylinders, as I then rejected it, as employed afterwards by Humphrys. Horton, by the use of two piston-rods to the low-pressure piston, and the placing the high-pressure cylinder between these two piston-rods, instead of the two side rods, as above explained, has added the only single idea that is worth a rush to my invention; but Rowan and him have added many ideas that render the invention very much inferior to what I made and employed it. By their modifications in the boiler they produced a boiler as complicated and impractical as my boiler was simple and practical, as proved by 15 years' every-day work, and those years were employed in improving all the details that were necessary to make as good a boiler as ever will be made. And it is now reproduced in what is called Howard's, of Bedford, boiler, but it will be found this reproduction is inferior to what the original in my hands was when I left it.

Now that I am upon the Boiler, I may as well call the reader's attention to all the modifications that I have presented to the public; they are found in the "Mechanics' Magazine," in my specifications of 1840, 1846, 1852, and 1857; see also the "Engineer" of Dec., 1857, p. 475, and the *Mining Journal* of June, 1853, p. 372, and of Aug. 18, 1858, pp. 545, 609, 657; and there are hundreds of persons who have seen my boilers as they were made by me, of that type fitted up in the Thetis, as it was to this type of boiler that for the most part I confined my manufacture, and a better or more practically workable boiler, or more economical in the generation of steam, engineers will not make. Some of the other modifications have their preferable points, but those I leave the reader to discover for himself; but I think the public never paid me a royalty, which produced them, they ought not to be called upon to pay royalty to those who simply reproduce them. I will assert of my water-tube boiler, when all the modifications of it which I have referred the reader to are impartially examined, I am in no fear but my assertion upon this point will be seen to be true. We must add a few words upon double-cylinder engines. In addition to the modifications explained was a grasshopper double-cylinder engine, also made by me in 1845. Now, the reader can distinctly see why the claim to the direct-acting modification of 1846 was limited in that particular, of which the "Engineer" availed itself to deny I had made any invention of any note whatever in the steam-engine, ignoring all the information I had given in the "Engineer" of 1858, and that of its own leaders; yet the original basis of that discussion, and those leaders of 1858, proceed from the evidence which my invention had by 15 years' daily work confirmed beyond all reasonable doubt, and which was placed in its basis and chief constructive details before the public in 1846. From this invention, this labour, and this cost were the texts supplied that were drawn out in leader after leader, as may be seen in the "Engineer" from 1858, up to even 1862. This modification in question the reader can see was used by me in the year 1843; it was adopted by Smith in 1844, No. 10,245, and therefore could not be claimed without limitation in my specification of 1846; but all this in no way detracts from my claim to its original production. There is the point of one and two cylinders, which is best illustrated in this place. During 1843 I was, as all others had been, mislead by the indicator, as its evidence alone indicated the inutility of double cylinders, and in 1845 I used two single cylinders, with which the basis of my invention was unalterably settled by my tracing the difficulty that in these cylinders beset me to the immutable laws which men cannot alter. It is singular that in the article Bourne inserted in the "Artizan" of May, 1844, this error of mine is the only point accepted and received as practically sound; but, in fact, it is the only point that my pamphlet of 1844 presented that was unsound. The same evidence which resulted from the use of these two single cylinders, in 1845, clearly showed me that with single cylinders superheating would require to be carried to a much greater extent than with the double cylinders; therefore, of these two I chose the double cylinder for my practical use for that among several reasons, some of which are found in the report of the Society of Mechanical Engineers, Birmingham, 1848; the *Mining Journal*, also, of 1848, pp. 214 and 226, and the "Mechanics' Magazine" of the same year, go upon this point. In this year, 1848, see the *Mining Journal*, p. 126, and the "Mechanics' Magazine," pp. 241 and 244, for further practical illustration of the use of the cranks of the double cylinders at angles, to render the two cylinders equivalent to two engines. Seeing that in 1840, in my specification, is given two single cylinders connected to cranks at right angles, and superheated by the hot gases, and that in 1842 I used the common boiler and one cylinder, and that in 1845 I used two single cylinders with the cranks at right angles, it is a strange kind of logic by which others, adopting the basis of my invention, can, by the use of the common boiler, or the use of the one cylinder engines, pretend that they are doing anything more than I had done, long before they believed in my reports of as positive facts as ever they reported upon any engines. The fact is, that with single, double, treble, or four-fold cylinders, I had combined my basis before the year 1857 plainly enough.

The references given to my 1846 combinations will bear out my assertion that what has been sold by hundreds as Holman's pump is seen in the "Mechanics' Magazine" of 1847, p. 156, as part of my invention, and as such was claimed by me in 1846. This pump, before 1849, I had made with double and single barrels, and sold it for air and water purposes. Yet, Holman patents it about 1852, and I had no knowledge of the fact until 1864. Further, I assert that the mode of governing the pressure of the steam in the boiler, the mode of preventing priming, that of diminishing or increasing the superheating surface by increasing or diminishing the surface above the water-line, and surrounding the whole exterior of the boiler by the hot gases, even to that of surrounding the ordinary brick casing by an outer flue, all these are mine. This last I practically applied in 1853, at Mackenzie's saw-mills, Pimlico; it is found illustrated in the *Mining Journal* in 1858, p. 545. For superheating, I assert they will never improve upon the way I did it, for the reasons that in this way the gases were exhausted of their heat by contact with the steam surface, so that on entering the chimney they were but slightly hotter than the superheated steam; and the outer case so effectually shut out the cold from the boiler that it could lose no heat, either by radiation or conduction; in these respects I had attained perfection on these points. In the boilers for the Thetis (which, bear in mind, were as much my production, so far as the invention and designing goes, as any boilers I had made at my own works), I had to adapt the same constructive details to the requirements of a sea-going ship as I had used in the Pimlico boiler; this I did in a way that attained that end, rendered the stoke-hole cool, and admitted of ready admission to any part of the boiler at any time; besides, the easy and entire uncasing and casing up again was rendered a work only of a few hours, which could be done by the stokers. This, like all the other parts of my invention, was simple and sound, as a structure, and realised the end in view, but was destined to be scattered to the winds, that pirates might claim my invention. After my 20 years' practical experience, during which time pirates had watched me, and learned from me that which they thought would enable them to gain the reward due to me, the design long entertained to seize the invention and obliterate the inventor's works was carried out, to assist an obliviousness which leads us to doubt if Craddock was not a myth. But, whatever may be the worth of technical education, natural aptitude is not the thing which it is to the interest of the British people to tread under their feet, or to allow to be trodden under foot by any army of pirates, even with their specially retained journals. One man can do nothing against such organisation, when the general Press treats inventors as having no claims upon it, so that no amount of injustice and inhumanity moves that which in other men's defence is a powerful auxiliary to check it, whilst the law in defence of the real inventor is the most complete mockery of justice that the brain of man could devise.

Now we come to the Valves, the connecting-rod, the mode of encasing the cylinders, and the working of the air-pump, and, if desirable, the condenser, by a separate engine. The valves, I assert, contain every quality that can be desired in valves; they are simple, adapted to the eccentric motion, work in equilibrium, and, consequently, however large the engine and its valves, or high the pressure of the steam, the equilibrium is always maintained, and one man can move them with the same ease as in starting and stopping a 4-horse portable engine. So completely is this so, that in a 20-horse engine, working with 100 lbs. pressure, and a vacuum of 13 lbs., in which the whole work was subject to be thrown off at once, so that the engine would fly away at such a velocity as to endanger the fly-wheel rim being by centrifugal force separated into parts, and driven through the walls of the engine-house; in this case, though the throttle-valve was made regrettably so perfect, that when closed a 100 lbs. pressure of steam caused not the slightest leak through it, yet it was found repeatedly in a very short time useless. In this case I substituted one of these valves with the equilibrium pressure-box, and it, as a slide-valve, became both throttle-valve and stop and start valve. It was connected with the governors, and the engine was thus brought under perfect control, the wear of the valve rather improving its action than the reverse. To stop the engine required only to expand, and hold expanded, the balls of the governor, and on letting the balls down depended the starting of it. To practical men, to whom this evidence will not carry conviction, further is useless. This valve was applied in 1854, and it was rendered perfect in 1857; for the verification of this see my specifications of 1854 (No. 1922), and 1857 (No. 931), in conjunction with those of 1846 and 1852 (No. 51), and the last specification of 1857 (No. 1162). In this last specification of 1857 is seen an intervening superheater, and further modifications of my regulating damper, also further modifications of my boiler; but upon these I cannot dwell. Whatever some persons may think or say privately about these valves, and mode of keeping them on the face, depend upon it they will be found to exceed in value all I have ever said of them. They will also be found to render the Thetis engines quite equal in all respects to the use of two single cylinder engines. Knowing this, is it surprising I retain the opinion that in all the alteration made in the Thetis engines after I left in 1857 (see the "Engineer" of this date, page 418, Dec. 4), everything done was in a retrograde direction, as the only thing that was not excellent in that engine, as far as I was concerned, was the valves—they did not time the steam to the motions of the pistons, consequently steam went to the condenser without doing work; this rendered the engine more difficult to start, and greatly reduced its speed when started, thus the full complement of steam went to the condenser, but the pump did not throw its complement of cold water into the condenser cistern, and, of course, the water became hot, and the vacuum sunk, which diminished still more the speed of the engine, and with it the quantity of cold water to the condenser. Much of this result was due to the kind of stopping and starting motion then used. Experiencing this defect in the reversing and starting gear, I devised that seen in my specification of 1857 (No. 931), which is as simple as the other was complex. But assume it was all due to that particular application of the valves, how insignificant is such a fact, resulting from this insignificant part of my invention, compared with the remaining parts of it; and what occasion to throw all the other parts out, but to crush the inventor, and for 15 years the manufacturer of this invention, in order that pirates and jealousy might triumph. Well, they did triumph, and I and the English public are the sufferers; on the other hand, others have gained, as they suppose, by it, but time will show how few in England are the gainers by it in the long run. Now, as to valves in connection with my invention, this paper shows I used the ordinary valves and steam-nozzels in 1842, and up to the end of 1844. Surely no person has so good a right to the first claim to that as I have in connection with my basis. And with my improved valves in 1846 I show them in a steam-box, held to their face in the common way.

Although Watt and others cased the long cylinders of their beam-engines, to keep the cold atmosphere from cooling them, by the use of steam in the case, yet such a thing was never thought of with the short stroke direct-acting engine, until done by me in 1852. Moreover, it was done by me not so much to keep the cold air from it, as to neutralise the effect of cold steam when expanding within the cylinders. But even in its completness it has been deemed worthy of being re-patented several times over. One of its peculiarities is that the working cylinders, being inserted like bushes, they can be taken out and new ones inserted, when worn out or otherwise injured, without deranging the casing, which has the passages, ports, and valve face cast with it. In my specification of 1852 (No. 51) all, and more than all I here claim for it, it is seen to possess. Here also is seen my connecting-rod; this rod enables us to use for length of connecting-rod all the distance from the top of the piston-rod to the crank-pin, so that oscillating and trunk engines lose their peculiar recommendations, as with this connecting-rod we get more than three times the length of the stroke, and yet the engine is quite as compact as the oscillating engine. The form given in the specification illustrates its principle, but I have given it a much better form than there shown. If any considerable number of Englishmen had the experience of the real inventor, they would say that of all men the inventor was the last person for which the laws by which he is protected and encouraged, should not be made direct, simple, and inexpensive, for the protection of his property, as, supposing it thus perfectly protected, he labours under great disadvantages. One of them, and not a light one either, is the prejudice and ignorance which he has to dissipate, after he makes his invention, before the public will accept that which is more valuable than sovereigns, and which he provides for it. This is especially so in inventions such as mine in the steam-engine, as even this simple connecting-rod, because it operates the reverse way to the ordinary side rod connecting-rod, has met with no end of private adverse criticism, which, by-and-bye, will be found all error. Again and again have I seen the credit, and, no doubt, the reward also was given to others for first working the air-pump by a separate engine, yet it belongs to me, as may be seen in the "Mechanics' Magazine" of 1847, Sept. 18, page 266, also in my specification of 1846, and my book, with 10 sheets of drawings and tables, published by Simpkin and Marshall in 1847. In those drawings of locomotive engines, and one found in the *Mining Journal* of 1847, page 446, is prefigured a mine of wealth, to which the public will some day be permitted to have access. Who can suppose the saving of coal to be of any moment in the minds of this and the passing away generation of Englishmen, when in the locomotive, and almost all other steam-engines, it is still thrown away, as it is, to make clouds in the atmosphere, and be swallowed up by the sea; and at the same time the steam companies are subsidised out of taxes drawn from the people, hundreds of whom die annually of starvation. Even my steam-gauge, found in my specification of 1846, is re-patented by Allen, and embodied in metal, which I suppose he considers is everything; but whoever looks into the matter will see, as I saw, it is only the same thing as another man's property. But here candour compels me to say I considered the mechanical gauges were rendered so cheap and good as to make air-gauges a thing of the past; and, therefore, on this part of my invention I spent little thought, and less money; but there it is, and let it speak for itself.

Now we come to the Condensers—for these see "Mechanics' Magazine" of 1843, page 176, my specifications of 1846, 1852, and 1857, No. 931, and you have condensers of the cheapest construction, suited to air or water, with permanently air-tight joints; suited to condense the steam direct, or cool injection water, to condense by injection. Here, as in my boiler, long practice enabled me to see every point that the most perfect practice demands, and all such points are provided for. But the condenser admitted of motion, therefore it could not stand still; therefore, a host of inferior, and more expensive, surface condensers must needs be produced by pirates, that would stand still, mud up, and leak at the joints. The Patent Office took 1000*l.* of me professedly to invest me with a legal title to that which I had a more sacred natural right to than ever had the owner of any estate. But after taking the 1000*l.* the Patent Office granted as many licences to pirates, to rob me of this invention, as chose to apply for them, and pay its fees for doing so. No person can mistake what my invention is any more than they can mistake what Watt's invention is, after what I have said even here of it.

Mr. David Mushet truly said my invention was not a bit a this and that, but a combination of principles, reduced to practice by proper constructive details—that is, the basis of the invention is in the combination of fluid principles reduced to practice by the detailed mechanical structures. As the modifications of the mere structural details are almost illimitable, such inventions under the present Patent Laws are suited to enrich the Patent Office, and create an army of pirates, but such protection as the Patent Office sells for 1000*l.* would be exceedingly dear as a gift when inventions of this class seek its equitable protection. That any branch of the State should enrich itself by luring from inventors their inventions, with a life-long labour, and enormous cost, to reduce them to practice, in the way the Patent Office does, aided, as it is, by laws and modes of applying them towards real inventors, shows clear enough that the State connives in this case at what it severely punishes in almost all other cases. It finds a few such human beings prepared, and, as it were, by natural aptitude impelled, to devote themselves to open up one store-house after another for the good of mankind, and such men not being able to bring any power to bear on the law makers and administrators, find the laws made and applied after the reverse order of that by which other men's property is secured to them. In my specification of 1854, No. 1922, is seen a mode for moving the expansive eccentric to any angle, even when the engine is in motion; this is worked by the governors, or it may be moved by hand. In this contrivance there is more originality than in 100 of the piratical patents. This some day will speak for itself, so will several other contrivances found in those five specification, beginning in 1840, and ending with 1857, which I have not noticed here. In your Journal for 1848, page 126, and also in the "Mechanics' Magazine" of 1848, pages 241 and 244, is seen other modes of mine for altering the action of the expansive-valve when in motion, and thus adjusting the power to the resistance in the best possible way.

Now, Sir, no candid person who examines what this paper refers to can fail to see that all the labour and mechanical structures, beginning with 1840, relate to one and the same combination of fluid principles, combined, as explained in my former letter in answer to "Engineer," to form my basis, and throughout constitute my invention, and form the foundation of all my writings upon the subject. This combination is from first to last embodied in mechanical structures, and has been the inspiring motive that has prompted their production and perfection; and what is this basis and the mechanical structures in combination when set in motion by heat, and these fluid principles? Why, a steam-engine in which to use steam from 30 lbs. pressure up to 400 lbs. pressure expansively, by the agency of suitable boilers, surface condensers, and engines, with the detailed appendages referred to in this paper, which, when united in their completeness, constitute the practically perfected invention upon this, my basis, as my published writings constitute the resultant of practical information derived from 15 years manufacturing and superintending of this invention in practice. The economical and other practical valuable results, which even I had for 15 years held up to the public gaze, constitute the practical evidence of its worth compared with what the bases and the engines made upon them could realise which I found in use in 1840. The public knowledge, practical and otherwise, could not fail to be enlarged and stimulated by this 15 years practical exhibition; if proof of this is required turn to the Patent Office, and the piratical patents suffice to show it. Bessemer, I see, counts up 30 in his case; but he might find four times that number in my case. We are often told that patents pay well; yes, when others make such invention, practically establish it, and educate the public to appreciate it; and so would the farm adjoining any of the rapidly rising cities in the United States which should now be confiscated from the pioneer for the benefit of him who, in the scramble, could first seize it for nothing. In the extract from Normand and Mallet's paper Randolph and Elder are commended for using the common boiler and moderate pressure. Was it not as commendable to do this in 1842 as in 1856, or are we to learn for the first time that a man having 10s. must of necessity go without food because the less valuable dinner costs but 1s.? As the several dishes are found in my invention, so, also, is that of one, two, or any number up to the best results I have been able to obtain. But, on second thoughts, Randolph and Elder add a third cylinder, as if by adding a quarter of a yard of carpet entitled them to the ownership of the roll containing 100 yards. Extract from Randolph and Elder's so-called invention what it is from this paper seen belongs to me, and exceeding little of any value beyond what the old bases and engines made upon them contained will be left.

What can be the reason that writers persist in dealing with inventors' rights in a way they would denounce as scandalous if their own literary productions were so treated. Suppose them Shakespear's Milton's, or anything you please, and give the credit of their productions to their publishers, and you have what they do by real inventors. But I shall be asked, who are the real inventors? Why, those who first make and demonstrate practically that something which before had no, or but a limited, property value, can have and has a value given it which it did not before possess. Thus Watt reduced the coal from 16 to 8 lbs. per horse power, and I from 16 to 1, or 8 lbs. to 1 lb., as the comparison is made with the condensing, or non-condensing engines I found in use in 1843. As Watt's steam-horse cost 8 lbs. of coal per hour to do its labour, and was exchangable in the market for more animal horses than Newcomen's steam-horse, which required 16 lbs. of coal per hour to do the same labour. In like manner, as my steam horse will do as much labour with 1 lb. of coal as Watt's did with 8 lbs., so, also, is it exchangable for more value by the animal-horse standard of value. It follows from this exchangable value that all these inventions had a property value given them by their authors, and were by them placed in the market of the world; and in thus doing men were supplied with each basis, and instructed how to continue the production of these steam-horses upon those bases. What land the basis to rear horses upon is, such these inventions are to raise steam-engines upon; and, as it is impossible that horses can be raised without land, neither would it be possible to raise each class of steam-engine until the inventions in succession were made on which each class of steam-engine is made. Why, then, demand rent for land upon which farmers rear horses, if you deny rent to the inventors who thus produce the inventions without which each class of steam-engine could no more be made than the animal horse without the land? But it will be said the horse becomes a ready-made animal on the land, and does not the steam horse in the workshop become a ready-made steam horse? This will be accepted, but coupled with the assertion that in the workshop labour and material cost money. When the farmer pays his rent, does his horse spring into being without further cost? No; there is the cost of dam and sire, the interest involved in dam, in rent of land for from three to six years, and the cost of labour, which must be chargeable in its due proportion upon each horse. The dam may fail to raise a colt each year, or the colt may be rendered worthless after three or six years' cost, so that the saleable horses cost the farmer little, if any, less than the steam horses, before the profit is added, even supposing the land rent was not paid. Let these considerations have their due weight, and, in addition, it may be asked, Why should some men invest 20,000*l.* or 30,000*l.*, and 20 years of labour, to produce such a basis, and have no property therein, whereas had they invested as much in land it would be a personal property, or, as it is called, a real estate? The reason is that men can confiscate the one, because its producers are too few in number to compel the many to deal justly towards them, though they are world-wide benefactors. The above reflections show that such real practical inventors make properties as much as if they invented 100,000 acres of land, as the difference between 16 and 8, and 8 and 1 lb. of coal, with the other values which each invention carries with it into practice beyond its predecessor, is of more value to England than had each actually invented 100,000 acres of land, or been able to roll back the sea to obtain it.

Deny it who may the fact remains, that a comparatively small number of men have rendered a greater service to England than had they been empowered to roll back the sea, so as to double the land area of the kingdom, with this additional recommendation, that in doing this they have at the same time not rolled the sea on to other lands, but have benefited all nations of human beings. One more illustration at this point; suppose I had written a book, to prove all which my invention in practice has proved in my hands, the book to some might have conveyed a feasible impression, but even in my own mind it must have left me in uncertainty, and to most it would, as experience shows, have been regarded as a nine-day's wonder, or at best but hypothetical. Hence we find Rankine making the facts brought out in practice by the working of the engines of the Thetis; and those made by Randolph and Elder, the corner-stone of all that is really new and practical in the matter of steam and the steam-engine in his manual, beyond what is found in other works. In truth, he finds from those practical results a foundation analogous to that of Pambour in the experiments made by the French Academy; and then like Pambour, he makes formulæ adaptable to a change of circumstances within a given range. In one of my letters, in reply to "J. B.'s" assertion that steam loses heat differently by doing work than by expanding into the condenser without doing work, I asked him to prove it by condensing the same weight of steam under like circumstances, excepting that of work, by passing it through the engine first without producing work, and then by doing work; and I dared to assert that he would find as much heat in the condensing water in the one case as in the other, and I ventured to say that the mere fact of the steam doing work, or not doing work, could not change the heat going to the condenser, and that such an idea was ridiculous. This experiment has not been made, at least I have seen no account of it. This thermodynamic hypothesis is first presented in its imposing form by Thompson in 1849, therefore assume it of practical value, which I disbelieve (and I have given my reasons for disbelieving in it) it clearly had nothing whatever to do in improving the steam-engine, as it has been following me, and not preceding me. All the facts of practical value it pretends to prove relative to the steam-engine I had previously established by the working of my steam-engines on a large and practical scale before 1849, yet "J. B." used it to prove I could not do what it was notorious I had done. The double-cylinder beam-engine is ascribed to Woolf, although it is notorious that it belongs to Hornblower; it was invented, made, and used by him to evade Watt's patent. It is, then, Hornblower's invention as much so as anything Watt ever invented was his. And the double, I may say the treble, and the fourfold cylinder direct-acting engine is mine, as much so as anything that Watt, Woolf, or Hornblower ever invented was theirs. Had Robert Stephenson, or Watt, and not Craddock, invented it, what denunciations would have been hurled at those who disputed it. But justice is not concerned with persons and names, but in awarding to each their own. In the *Mining Journal* of Dec. 10 and 17, 1859, are two letters, prompted by Rankine's "Manual on the Steam-Engine," &c., relating to the engines made by Randolph and Elder, and those in the Thetis; the letters furnish all requisite reference to guarantee the practical soundness of the facts, but here only the leading facts will be noticed, which are as follows:—My boiler gave 13·56 lbs. of steam for 1 lb. of coal; this steam used in the Thetis engines, cut off at 1-15th of the stroke, gave a practical result of 1·018 lbs. of coal per horse-power per hour. In the engine made by Randolph and Elder the boiler made 7·27 lbs. of steam per 1 lb. of coal, and the steam was so used, cut off at 1-5th, as to give the practical result of 2·97 lbs. of coal per indicated horse-power per hour. Here is seen my invention in its more and less advanced state, giving in the one case near three times the power per 1 lb. of coal it does in the other. But note also the comparison with marine-engines in 1849. John Seward, in a paper read at the Institute of Civil Engineers, which he prepared by the request of Government in 1849, says 25 lbs. absolute pressure was that then used, at full pressure; this would give 21 lbs. average effective pressure on the piston throughout the stroke, which is the average pressure on the Thetis piston surface with the steam cut off at 1-15th of the stroke, so that we have the size of cylinders for equal power the same, but the coal as 1 to 7 lbs. in favour of my engine. Another fact here is that for equal power the Thetis piston surface is 61 per cent. less than in the engine made by Randolph and Elder. In 1848 I first brought my invention under the notice of the Government. Seward's paper is found in the "Mechanics' Magazine" of Dec. 29, 1849.

We have Clayton and Shuttleworth credited with the first superheating of the steam by taking the hot gases round the cylinders, yet it is seen as part of my 1840 specification. The risk is in its rendering the rubbing parts so dry, especially in vacuum engines, as quickly to destroy them, and I soon found it was better to dry the steam, and superheat it in the boiler and steam-chest by the gases, than use them round the cylinder, and that then of all casing superheating that of the steam case was the best, and most controllable. Then we have McNaught, Sims, and a host of others, but in giving them all that is really their due do not overlook the fact that I was always in advance of them, as the date of their patents show, therefore treat the first in my case as in that of Watt, and others; for it is absurd to say such men did not know what I had done, as the publicity and novelty of using steam at 100 lbs. pressure in a condensing-engine, and also condensing by the atmosphere, when the highest pressure the locomotive used was 60 lbs., excited the curiosity of men to a degree in that day which is not now easily recalled. Therefore I call attention to the men named, as the list would be too long to enter upon which should include all that have followed me, but have been preferred before me. If I were in advance of those named then assuredly I was of those who came into the field at the eleventh hour, which as their works and patents mark the time at which each entered, and what he did, all may, if they will, find out what is just to me, and what is due to them. Recollect, the proof here given that I used the common boiler and valves, and single cylinder, with steam at pressures from 30 lbs. upwards. THOMAS CRADDOCK.

44, *Friston-street, Birmingham.*

[For continuation of Original Correspondence, see this day's Journal.]

GAS FROM PETROLEUM REFUSE.—The announcement that an invention had been introduced in Canada, by which petroleum refuse could be advantageously employed in the production of illuminating gas, having attracted considerable attention in this country, it will not be uninteresting to notice the nature of the substance with which it is proposed to deal. It has been stated that the gas can be obtained by merely forcing atmospheric air through a certain quantity of the material contained in a barrel or other suitable vessel, the application of heat being unnecessary; so that it is apparent that it is only the lighter products that can be referred to. Hitherto the use of these products for domestic purposes has not been general in this country, and in the United States, where they have been more largely employed, the results, owing to the frequent accidents attending their use, can scarcely be regarded as satisfactory. In a recent number of the *Scientific American* two disastrous accidents arising from the explosion of the lighter products of the distillation of petroleum are mentioned, as warnings to those who use or deal with these highly inflammable substances. The first happened in Ohio, where the escaping gas from a reservoir of gasoline destroyed a handsome dwelling, and seriously injured several of the inmates. The building was lighted by an independent gas apparatus, the reservoir of the liquid gasoline being at some distance from the house, the vapour being conducted to and through the dwelling by pipes in the ordinary manner, as is the common gas. Steam was used to heat the gas generator in excessively cold weather; but the gas pipes in the building had been leaking for some time, and the flame of a candle ignited the free gas in the basement, producing an explosion that nearly destroyed the building. The other case occurred in Pennsylvania, where a tank of benzine exploded, two men being burned to death, and the distillery in which the tank was located destroyed. The terms gasoline, benzine, benzole, and naphtha are not unfrequently used indiscriminately to denote the more volatile portions of natural earth oil, or petroleum, released during the process of distillation or refining. Chemists use these terms in a more restricted or exact sense; but these products are so little removed from a gaseous state that they continually and spontaneously give off inflammable and explosive vapours at comparatively low temperatures, which require but a spark or a flame to instantly ignite, when the result is similar to the explosion of gunpowder.

IMPROVED PUMP.—In raising large volumes of water, and especially when the height exceeds the action of the atmospheric pressure, and to this is added the necessity of forcing it a still further height, the general practice has been to apply the power—steam or otherwise—directly to an engine that drives the pumps, which are usually combined lifting and forcing pumps. It is evident that the amount of power thus used must be greater than if the action of the atmosphere were also employed. In the *Scientific American* an improved pumping-engine, the invention of Mr. A. J. Reynolds, of Detroit, Michigan, is illustrated and described. The Reynolds's steam condensing and water elevating engine described is double, and the pistons are reciprocatory in action by means of a walking beam. The cylinders may be called steam cylinders, although they also receive water. These are bolted to the lower or condensing cylinder. In the upper cylinders are plungers of wood, which merely float on the surface of the water in the cylinders. These plungers or pistons are pierced through with a series of holes forming passages for the water. On the lower side these may be closed by a floating valve, and on the upper side by a metallic ring valve, guided in its vertical movement by rods passing through stuffing-boxes in the upper cylinder head. The bars forming portions of a permanent frame serve as guides for the rods. There is a steam-pipe furnished with a gate, and having two branches, in each of which is a trip valve, operated by lugs on the lifting rods. This reference to the parts will be sufficient for a comprehension of the operation of the machine—inlet and outlet valves being, of course, provided. The central piston rod rises with the piston and carries with it a lifting bar, furnished with a lug to raise a lever and admit steam when the piston has nearly reached the top of the cylinder, and thus the steam is admitted to the cylinder above the piston. The pressure of the steam on the valve and piston forces them down until the nuts on the top of the guide rods strike on the frame, when the valve is lifted, and the water and steam rush down, the descent of the former being due to the force of gravity—it having a fall of about 5 feet—and the steam being almost instantly condensed as it comes in contact with the water, thus forming a vacuum above the piston. The downward rush of the water closes the inlet valve, and the water is delivered to the tank through the outlet valve. Now the return stroke is produced, as soon as the downward stroke is completed, by the atmospheric pressure lifting the water into the vacuum caused by the condensation of the steam. The first product of the effort is a closing of the valve under the piston, permitting no water to pass above the piston, and by means of the cap valve, closing as soon as the plunger reaches the position of the suspended valve, making again a solid piston for the action of the steam. It will be seen that all the movements are automatic, and that a description of a single reciprocating stroke explains the continuous action of the combined machine. Mr. Reynolds states that the condensation and consequent forming of a vacuum is so rapid that he has been enabled to produce 15 strokes per minute with a pressure of only from 10 to 15 lbs. of steam, raising water to a height of 25 feet. The engine would operate with very much less steam, although not so rapidly, as the momentum of the water is accelerated by the steam pressure, yet a larger amount of steam has be to condensed to create a vacuum, which, however, is assured by the large surface of the condensing cylinder. This cylinder is kept continually cool by a non-conducting packing between that and the upper cylinder, aided by the non-conducting material of the plunger and its lower valve. It will be noticed, also, that the lower or condensing cylinder is kept continually filled with water, the level of which corresponds with that of the water in the receiving tank. Surplus stream, air, and gases are forced out through a check valve in the top of the upper cylinder by the momentum or hammer of the water, obviating the necessity of air-pumps, syphons, or similar contrivances, and making a very cheap and

direct acting device for raising water. For draining mines, wrecking purposes, pumping for railroads, elevating water for supplying cities, towns, and villages, and for producing a water power by creating a head, this machine is believed to be applicable and efficient; 45 barrels of water can be raised 25 feet high per minute with this machine, and a 10-horse power boiler carrying 25 lbs. of steam.

FOREIGN MINES.

CHONTALES GOLD AND SILVER MINING COMPANY.—John Tonkin, November: Consuelo and Estrella Mine: No. 1 stope, in the back of No. 3 level, east of No. 3 pass, has been stoped 9¼ varas; lode 3 ft. wide, worth 7 dwts. of gold per ton. No. 2 stope, in the back of No. 3 level, east of No. 3 pass, has been stoped 13¾ varas; lode 3 ft. wide, worth 5 dwts. of gold per ton. No. 3 stope, in the back of No. 3 level, east of No. 2 pass, has been stoped 14½ varas; lode 3 ft. wide, worth 3 dwts. of gold per ton. No. 4 stope, in the back of No. 3 level, east of No. 3 pass, has been stoped 8 varas; lode 3 ft. wide, worth 5 dwts. of gold per ton. No. 5 stope, in the back of No. 3 level, west of No. 2 shaft, has been stoped 13 varas; lode 4 ft. wide, worth ½ oz. of gold per ton. A stope in the back of No. 2 level, east of No. 2 shaft, has been stoped 9 varas; lode 4 ft. wide, worth ½ oz. of gold per ton. A stope in the back of No. 2 level, east of No. 1 shaft, has been stoped 7 varas; lode 4 ft. wide, worth 3 dwts. of gold per ton. A stope in the back of No. 4 level has been stoped 11½ varas; lode 6 ft. wide, worth 2 dwts. of gold per ton. Our yield of gold has fallen off this month, in consequence of a poor bar of ground being in the back of No. 3 level, and which had to be taken away. I hope by continuing these stopes higher up we shall meet with our general run of ore ground. No. 3 level east, on the course of the lode, has been driven 2½ varas; lode 3 ft. wide, with a little gold, but not sufficient to value. Piper's shaft has been sunk on the back of No. 4 level 6 varas on the lode, which is 4 ft. wide; in this shaft we have met with several small deposits of gold, worth 2 ozs. of gold per ton, which being taken down, together with the whole lode, is worth ½ oz. of gold per ton; should this lode hold on good in a short time we can raise a good supply of quartz from this place, and I hope in three months to communicate this shaft with No. 4 level, and at the same time open up a large piece of new ground. The quartz sent to the mill for the month is 595 tons from the mines, which I estimate to be ⅓ oz. of gold per ton, and 170 tons from the old heap, which I estimate at 1-5th oz. of gold per ton; in all I estimate 233 ozs. of melted gold.

W. Evans, Dec. 4: Santo Domingo Mine: During the past month the operations of the mines have been carried on satisfactorily. The No. 3 level has been driven east on the course of the lode through the old workings 11 varas, yielding 6 dwts. of gold per ton of quartz. The lode being broken and mixed with clay is the cause of the quartz being so poor. I have suspended the driving of this level for the time being, to stope the back of it, where I hope to get some rich pillars. No. 1 level, west of San Antonio tramway, has been driven 18 varas through broken ground. It was my intention to have communicated this level with No. 3 level, driving east to ventilate and facilitate the future working of the mine. This level being poor and difficult for driving, owing to broken ground and bad air, caused by the old timber, I have deemed it necessary to suspend the driving of this also. I have put the men who were employed in these levels to sink a winze in bottom of No. 3 level, which has been sunk 2 varas on the lode; the lode is 3 ft. wide, yielding 1½ oz. per ton of quartz. This winze is being sunk in whole ground. I intend to push on the sinking of this winze as fast as possible, as I think it to be one of the most important workings we have, and as soon as this winze has attained its proper depth levels will be driven and stoping commenced at once. I have just commenced also to stope the No. 1 stope, in back of No. 3 level, which yields 5 dwts. of gold per ton. No. 2 stope, in back of this level, has been commenced also, and yields 5 dwts. of gold per ton. No. 4 stope, in back of No. 3 level, has been stoped 10 varas, yielding 4 dwts. per ton. No. 1 stope, in back of No. 1 level, west of San Antonio tramway, has been stoped 6 varas, yielding 4 dwts. of gold per ton. No. 2 stope, in back of the same level, has been stoped 5 varas, yielding 5 dwts. of gold per ton. West San Benito tramway has been pushed on with all speed. I hope to get it completed in about 15 days. I hope in a week from now to complete this road as far as Trinidad Mine, when I will commence to send down the quartz which is lying on the side of the road, which I find from samples taken will give 5 dwts. of gold per ton. West San Benito deep adit level has been driven west on the course of the lode 17 varas: the lode is 5 ft. wide, producing a little gold, but not to value. Trinidad level has been driven east on the course of the lode 11 varas; the lode is 5 ft. wide, which is very hard, and not yielding sufficient gold to value. During the past month I have sent to mill 179 tons, averaging 5 dwts. per ton.

San Antonio, William Martin: During the past month the working operations, both in and outside the mine, have been carried on most satisfactorily. The deep adit level, west of shaft, has been driven on the course of the lode 7½ varas; the lode at present is small—about 2½ ft. wide. During the past week, according to samples taken, it has given 6 dwts. of gold per ton, and will give about 3 tons of quartz per fathom, though to-day it is not quite so good. The stopes in back of the deep adit level, west of shaft—No. 1 stope has been stoped 45 feet; lode 3 ft. wide, yielding 12 dwts. of gold per ton of quartz. No. 2 stope, in back of the same level, has been stoped 44 ft. 6 in.; lode 2½ ft. wide, yielding 12 dwts. per ton of quartz. No. 3 stope, in back of the same level, has been stoped 39 ft.; lode 2½ ft. wide, yielding 12 dwts. of gold per ton of quartz. The level in bottom of old San Antonio shaft, has been driven west 8 varas; this level wants about 10 varas more to reach the old footway shaft. As soon as this level is communicated with the old footway shaft stoping might be resumed in back of this No. 2 level. There has been sent to the mill the past month 233 tons of refuse from San Benito Mine; also from top of the hill 29 tons of refuse.—East San Antonio Mine: I have sent to mill, from refuse and stopes altogether, 342 tons of quartz, which will yield 6 dwts. of gold per ton.

JAVALI.—The directors have received advices from the managing director at the mine, dated Dec. 8. The expenses for November had been reduced to 3583. No drafts were drawn for December, the money on hand being sufficient for that month; 1000 ozs. of amalgam was estimated to be ready for retorting, but Dr. Seemann preferred to send it and the next month's remittance together. Pim's Tunnel was within a few feet of the Nispero workings. A door and portico were being erected at the mouth of Pollock's Tunnel, in view of its being immediately connected with the Socorro, so as to then protect the latter from plunder. The health of the mine was excellent, labour was abundant, and an arrangement was about being completed with the Chontales Company to regulate and reduce the price of native labour.

ANGLO-ITALIAN.—Mr. Pearson Morrison reports:—The various cross-cuts referred to in former reports have progressed at about the same rate as per last advice. The general advance, however, is slow, owing to the extreme hardness of the schistose rock. This I hope in time to improve upon by the introduction, if possible, of one or two small drilling machines, having already made enquiries respecting them. The general appearance of the mine I consider favourable, but requires extension both in length and depth ere regular and large monthly returns of ore can be looked for, and to attain this a large extent of dead ground has to be passed through, besides numerous other openings along the course of the lode, requiring both time and money; until these are completed I wish it to be clearly understood I hold out no promises of either steady or remunerative returns.—[Mr. Morrison estimates the entire cost for the next six months at 3000l.; machinery, 1700l.]—Reduction Works: 21 mills have been in full operation for the last 10 days grinding inferior ore, so as to wear away the irregularities of the stone and to form a bed. The result of a few tons of ore passed through the mills gives an average of ⅛ oz. of gold per ton; but owing to the frost and the imperfections of the present mills (they being, as you are already informed, erected solely for testing purposes) I estimate that not more than 30 per cent. of the gold contents is extracted. The results, however, are sufficiently favourable to warrant the erection of 10 heads of stamps, in connection with classifiers and percussion tables capable of treating about 400 tons monthly. These will be erected in such a way that other heads may be added in proportion to the increase of ore raised. The above works I hope to have in full working order about July next; the estimated cost will not exceed 1500l. Mr. Dietzsch, the reduction officer, is meanwhile engaged in the building of an assay furnace for testing the various parcels of mineral lately discovered on the new concessions and other parts of the old mine. Under letter dated Jan. 6, Mr. Morrison also states that he is pleased to say that Mr. Dietzsch has decided to accept the post of reduction officer, and that from the little he has already seen he is of opinion that with the proper appliances there will be no difficulty in the thorough separation of the gold.—[The directors regard the appointment of Mr. Dietzsch as most advantageous one to the company, and they think it right to inform the shareholders that this gentleman held the post of reduction officer of the St. John del Rey Company, and that he came home from the Brazils with a strong recommendation from Capt. Thomas Treloar, the consulting engineer of the Don Pedro North del Rey Gold Company, to the chairman, who had applied to Capt. Treloar to select a suitable officer.

ALAMILLOS.—Jan. 2: In the 4th level, driving east of La Magdalena shaft, the ground is hard for driving, and the lode small. The 5th level, east of La Magdalena shaft, yields 1 ton of ore per fathom; the lode is large and strong, with fine lumps of ore. The lode in the 5th level, west of the same shaft, is disarranged at present. The 5th level, east of Taylor's engine-shaft, opened good ore ground in the past month, but is of little value at present. In the 5th level, west of this shaft, the lode is large, and contains spots of lead. The lode in the 4th level, west of San Adriano shaft, is small, and spotted with ore. In the 3d level, west of San Yago shaft, the lode is unproductive at present, but lets out much water, and looks promising. The 2d level, east of Cox's shaft, produces 1 ton of ore per fathom; the lode is very wide, and easy for driving. The 2d level, west of Cox's shaft, is worth 2 tons per fathom; in this end, also, the lode is open and of a kindly appearance, yielding large boulders of lead ore. In the 2d level, east of Judd's shaft, the men are put to open the north side to prove the main part of the lode. In the 3d level, east of Crosby's shaft, the lode is improving, and yields a little ore. The 3d level, west of Perez' winze, being unproductive, is suspended for the present. The 2d level, west of Morris's shaft, is stopped temporarily while the men sink a winze below the bottom of the level. The 2d level, east of Henty's shaft, yields 1 ton of ore per fm.; the lode is getting rather smaller than it was. In the 2d level, west of Henty's shaft, the lode is again improving, and opens good tribute ground, worth 1 ton of ore per fathom.—Shafts and Winzes: Taylor's engine-shaft will be completed to the required depth for a 6th level in the middle of the month. San Enrique shaft has reached the 4th level, and the men are cross-cutting towards the south lode. Tomas' winze, below the 4th level, yields ¾ ton of ore per fathom; the lode is large, strong, and hard for sinking. Agueda's winze, below the 4th level, produces 1½ ton of ore per fathom; the lode is very wide, and spotted throughout with lead. Prim's winze, below the 4th level, is going down in a large loose lode, and yielding 1 ton of ore per fathom. Guirado's winze, below the 3d level, is worth ¾ ton per fathom: this new winze is situated east of San Enrique shaft, on the north lode. Gandia's winze is also a new sink, east of Crosby's cross-cut, and produces 2 tons of ore per fathom. In the tribute department, the lode being less compact than it formerly was, the number of stopemen is increased, in order to keep up the present monthly rate of raisings. The general surface work is going on very well, and the machinery in good order. We estimate the raisings for January at 250 tons.

LINARES.—Jan. 2: West of Engine-Shaft: The lode in the 110, west of Santo Tomas engine-shaft, contains good stones of ore in the upper part of the end. The 85, west of Warne's engine-shaft, showed indications of improvement last week, but has again failed, yielding now only ½ ton of ore per fathom. The lode in the 85, east of Warne's shaft, is looking better than it has since the end was started from the shaft, and produces 1 ton of ore per fathom. The 45, east of San Francisco shaft, yields 2 tons per fathom. This is opening a good length of tribute ground. In the 31, east of San Francisco shaft, the lode, which appears to be declining in value, is worth 1 ton per fathom.—East of Engine-Shaft: The 95, east of Taylor's cross-cut, yields 2 tons of ore per fathom. This driving opened some valuable ground in the past month, and is still looking well. The lode in the 95, east of Taylor's shaft, is large and strong, yielding ¾ ton of ore per fathom.—Shafts and Winzes: The ground in San Francisco shaft, sinking below the 31, is very hard, and the lode small. No. 163 winze, below the 85, is now deep enough for the 95 fathom level; the lode is quite poor. In No. 162 winze, below the 31, the lode, which yields 1 ton of ore per fathom, is rather small, and the ground hard for sinking. No. 164 winze, below the 25, also produces 1 ton of ore per fathom. The lode here is open, and of a kindly appearance, and is easy for driving. The stopes yielded a fair quantity of mineral in the past month, and are looking favourable for the present one. The surface works and the machinery are going on very regularly. We estimate the raisings for January (five weeks) at 325 tons.—Quinientos Mine: The lode has greatly improved in the 32, west of Taylor's engine-shaft: it is now large, and of a kindly appearance, yielding 2 tons of ore per fathom. The 32, east of Taylor's shaft, has passed through a small cross-course, and is somewhat disarranged. In the 32, east of Addis's shaft, the lode is large and strong, with good stones of ore. There is a good lode in the bottom of the end of the 32, west of Addis's shaft, yielding ½ ton per fathom, but it is small in the upper part.—Shafts and Winzes: In Taylor's engine-shaft, sinking below the 32, the work is going on very regularly. The men are working well in Cox's shaft, sinking from surface, but the ground is getting harder, and the water stronger. San Carlos shaft, below the 1st level, produces 1½ ton of ore per fathom. There are old works in the bottom of the shaft, and unmistakable signs of there having been a very fine lode. We are now breaking from a north branch some very fine stones of lead.

FORTUNA.—Jan. 2: Canada Incosa Mine: In the 110 fm. level, east of O'Shea's shaft, the lode is open, and letting out water, but is at present poor. The 100, west of O'Shea's shaft, yields 1 tons of ore per fathom; the ground is hard for driving, and the lode small. In the 90, west of Judd's shaft, the lode, which produces 1½ ton of ore per fathom, is very regular, and continues to open good tribute ground. In the 80, south of Henty's, the ground is hard for driving, and little progress is being made. The lode in the 80, west of Judd's, is small; the driving is suspended while the men sink a winze through to the 90. The lode in the 90, east of Addis's shaft, has a kindly appearance, and produces good stones of ore occasionally. The 70, east of Carro's shaft, produces 1¼ ton of ore per fathom; the lode, although not so good as it was, still opens out good tribute ground. The lode in the 50, east of San Pedro shaft, is large and strong, producing good stones of lead ore.—Shafts and Winzes: In Henty's shaft, sinking below the 100, the men got on badly last month, but we expect greater dispatch will be made in the present one. Lowndes's shaft, below the 75, yields ¾ ton of ore per fathom; the men are getting on very well in this shaft—the lode is smaller than it was. Diaz's winze, below the 55, is holed to the 75; the lode is worth 1¼ ton per fathom. Casada's winze, below the 40, produces 1 ton of ore per fathom; this is deep enough for the 50, and will be through by the end reaching it shortly.—Los Salidos Mine: The lode in the 100, driving west of Morris's engine-shaft, is yielding ½ ton of ore per fathom. The 75, west of Buenos Amigos shaft, produces 2 tons of copper ore per fathom; the lode continues in two parts. In the 100, east of Morris's engine-shaft, the lode is disarranged at present, but we expect an improvement shortly, as it is near Prim's winze. The lode in the 90, east of Cox's shaft, is worth 1¾ ton per fm.; the lode has much improved, and is now very strong, and of a kindly appearance. The 75, east of San Pablo shaft, is worth 1½ ton per fathom; the lode is kindly lode, and opens moderately productive ground.—Shafts and Winzes: In Prim's engine-shaft, sinking below the 90, is nearly deep enough for the 100, and will be completed shortly. In Tomas' winze, below the 65, the lode, which has a kindly appearance, is worth 1¼ ton per fathom. The lode in Ramon's winze, below the 75, is rather small at present, yielding 1 ton per fathom. Prim's winze, below the 90, is worth 1½ ton per fathom; the lode has fluctuated considerably in this sink—it will reach the 100 this month. Murillo's winze, below the 75, yields 3½ tons per fathom; this winze is west of Buenos Amigos shaft, and in advance of the 90 west. The tribute department has not undergone any change worthy of notice in the past month, and looks moderately favourable for the present. The new engine at Los Salidos was set to work on Dec. 23, and goes remarkably well; the other engines also are in very good working order. We estimate the raisings for January (five weeks) at 450 tons.

IMPERIAL SILVER QUARRIES.—Lewis Chalmers, Dec. 14: Owing to the excessive hardness of the rock last week, only 8 feet of tunnel were made. I was in hopes to have received ere now either Penrice's or some other drilling and time saving machine.

[For remainder of Foreign Mines, see this day's Journal.]

VARLEY'S PATENT SELF-ACTING BOILER FEEDER.

An apparatus for feeding boilers, which should combine the qualities of safety and certainty, and be at the same time self-acting, has long been a desideratum with steam users. The idea has been worked out in various ways at various times, but with very partial success. We appear now, however, to have an apparatus which fulfils all the above conditions, and embodies other points of superiority over the numerous family of pumps and injectors now before the public. This apparatus is VARLEY'S Patent Self-Acting Boiler Feeder and Water Measurer, of which we give engravings herewith. This important invention secures perfect safety against explosion, and is self-acting, working quite independently of engine power. By its aid a uniform water level is maintained in the boiler, and the quantity of water used or evaporated is measured and indicated. By this means valuable information is afforded, as it acts as a check upon the condition of the boilers and the quality of coal used. It possesses a special advantage over the injector, in that it will lift water from any depth, not exceeding, of course, that to which the action of an ordinary pump extends.

FIG. 1.

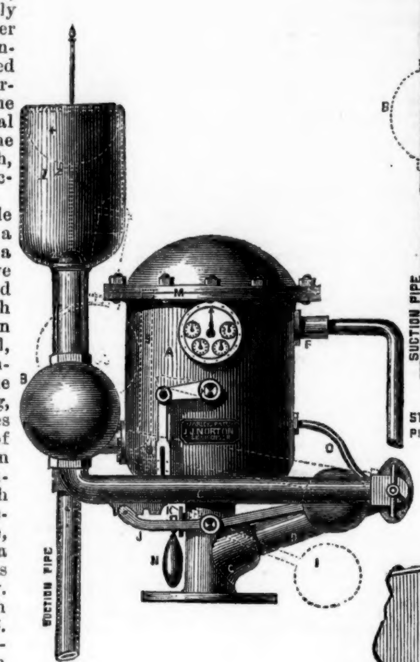
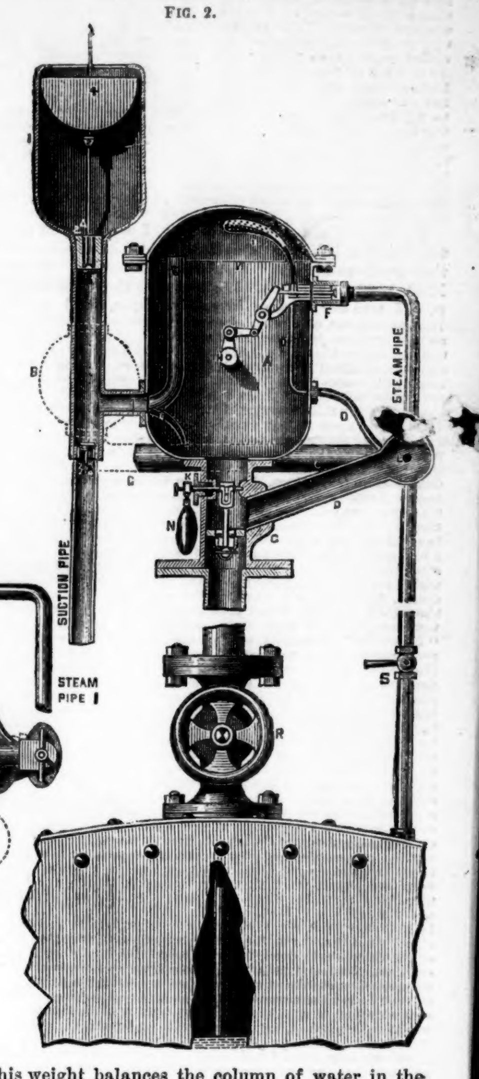


FIG. 2.



Our engravings show, at Fig. 1, an outside elevation of the boiler feeder, Fig. 2 being a vertical section of the instrument as fitted on a boiler. A is a fixed copper vessel; F, a valve for the supply of steam from the boiler, and which is worked by the shaft, H, passing through the vessel, A. The ball, B, works or rocks upon the joint, I, and communicates with the vessel, A, through the pipes, D and C, and it is counterbalanced by the weight, I, which works the index and the steam-valve, F. On the casting, G, is a valve, through which the water passes from the feeder into the boiler. At the side of the vessel, A, is a small vessel, I, partially open at the top, and to which is attached the suction-pipe. Inside this vessel is the float, 4, to which two valves, 2 and 3, are attached. When in action this vessel holds sufficient water, which, when injected into the vessel, A, will create a vacuum. The back valve, 3, in Fig. 2, prevents the water returning into the source of supply. The two vessels, I and A, communicate with each other by the pipe having two branches, 5 and 6.

The action of the apparatus is as follows:—We will assume it to be in the position shown by the dotted lines in Fig. 1, when the steam-valve, F, and the outlet-valve in the casting, G, are both shut. The steam having been cut off the vessel, A, is in a heated condition; the water held in the reserve vessel, I, being liberated from pressure, flows through the valve seat, 2A, into the vessels, A and B, producing a vacuum, which will lift the water from the well, and fill the vessels, A and B, the former up to the flange, M. The weight of the ball, B, being increased by the water, causes it to fall to its lowest position, and in so doing it opens the steam-valve, F. The steam passes by means of the internal pipe, O, Fig. 2, to the top of the water in the vessels, A and B, and an equilibrium of pressure being established between the feeder and the boiler, the water passes from the former to the latter, as required. Until the ball, B, is empty it is held down by the cam, K, when the weight, I, will raise it to the position indicated by the dotted lines in Fig. 1, and the apparatus will repeat the operations described. Whilst the water is passing from the feeder into the boiler it also enters the reserve vessel, I, by the pipe, 6, until a sufficient quantity has been obtained for the next injection. This is determined by the float, 4, rising with the water until the valve, 3, finds its seat, where it remains, holding the water in readiness for the next charge.

We now come to the method of maintaining the water level in the boiler, which is effected in the following ingenious manner:—The valve in the casting, G, opens downwards, and is kept in its place by the weight, N. This weight balances the column of water in the feed-pipe between the feeder and the water level in the boiler, so that until the water in the boiler sinks low enough to increase the weight of the column of water in the pipe the valve remains closed. As soon, however, as the water falls below the desired level, it increases the length or distance between the water level in the boiler and the feeder, and the increased weight of the column of water acts upon the valve and opens it, the feeder, of course, resuming its working until the proper water level is reached in the boiler.

It will thus be seen that this boiler feeder combines two perfect instruments in one—a self-acting boiler feeder and a water-meter—thus forming an important adjunct to the steam-boiler. These feeders are manufactured by Mr. J. L. Norton, of 38, Belle Sauvage-yard, Ludgate-hill, a gentleman well known as having introduced the Abyssinian tube-well. We may add that one of Varley's boiler feeders is working at Messrs. Hayward and Tyler's factory, in Whitecross-street, whilst another is in use at the Hodge-lane Dye Works, Pendleton, Manchester, and both are giving every satisfaction.

BALLARAT is well known to English readers as the name of the centre of the gold digging area of the colony of Victoria. But it is not generally remembered that the very ground on which the town stands proved a perfect magazine of the precious metal to those who first turned over the soil, and submitted it to the action of the "pan." Forty millions sterling have been taken out of the space now covered by streets and houses for the abode and traffic of a population of 40,000 people. This number is daily increasing, for, besides being a sort of capital for the mining interests of the colony, Ballarat is also the chief town of the most productive agricultural district in Victoria. Business sites, therefore, fetch a high price, and only in August last a frontage in Sturt-street sold for 50l. per foot, which the buyer had himself parted with ten years ago at the very different figure of 20s. per foot. The architect and mason are now longing to bring under their dominion plots at the west end of Ballarat, to which streets already extend; but experience has shown the owners that the ground should be first carefully tested as to its auriferous properties. Three-quarters of a million was taken out of a narrow strip, somewhat over 600 yards in length, now lying in the very centre of the town. Twenty-two companies, whose operations have been confined within the municipal boundaries, have distributed to their shareholders no less than 2,225,000l. in dividends on a called-up capital of 890,000l. To estimate the value of their property we must add the cost of their plant and the quotation of their stock. Those best acquainted with the district and its gold-bearing history maintain that we have much yet to hear of the wealth of Ballarat and its immediate suburb. The failures, no less than the successes, of 15 years have served accurately to mark out the course taken by that now absorbed river, which once rolled the precious fragments in its torrents. Its current flowed westward, and has yet to be followed many miles from Ballarat in that direction before the search will be found unremunerative. The most successful companies now working there are getting gold from a depth of 400 feet and more. Such a depth is beyond the digger, but is no hard task for the miner, who will sink two shafts and erect his steam-engines, and if he find the river dip will not shrink from diving after it. Where the river has run deepest there the bottom will be found most prolific in gold. But to reach this oldest and purest deposit large sums must be employed, sufficient not only for deep mining, but for operating over a wide area at one and the same time. To do this, British capital must be called in, and the time is at last arrived when the stay-at-home investor will have his chance of sharing in the enormous dividends that our Australian cousins have hitherto shared amongst themselves.

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